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VOL. X. NEW YORK, DECEMBER, 1905. No. 10.

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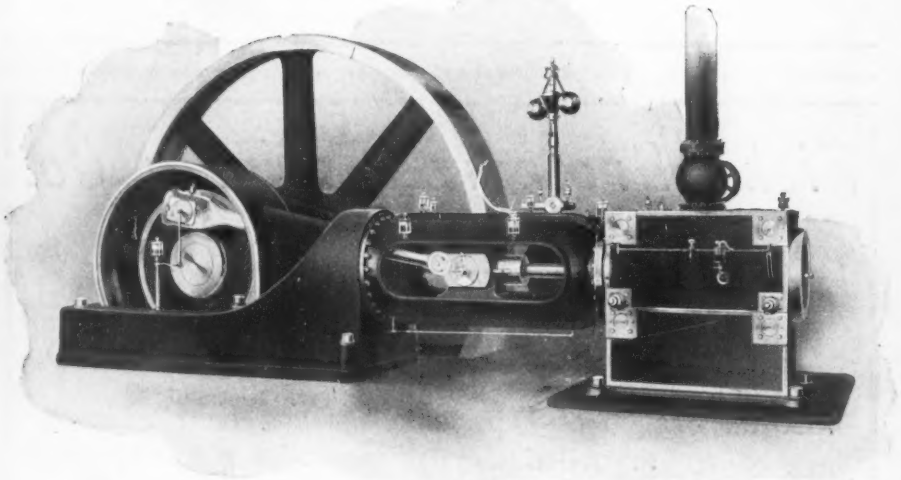

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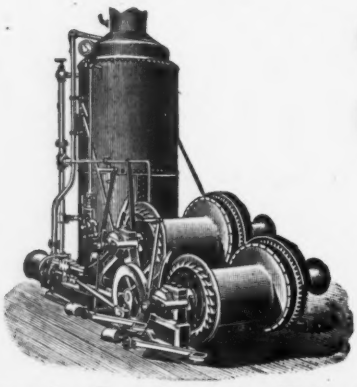

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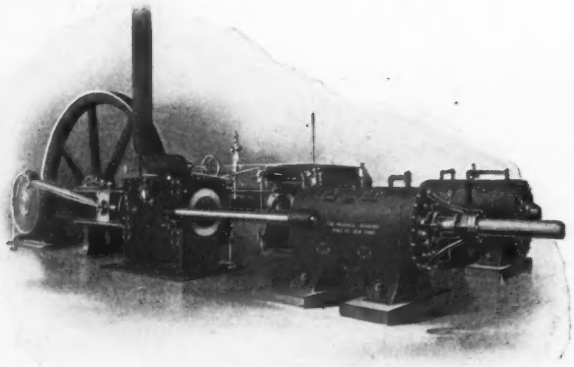

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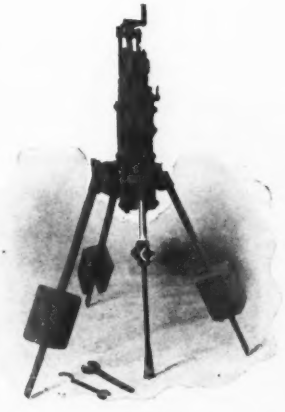

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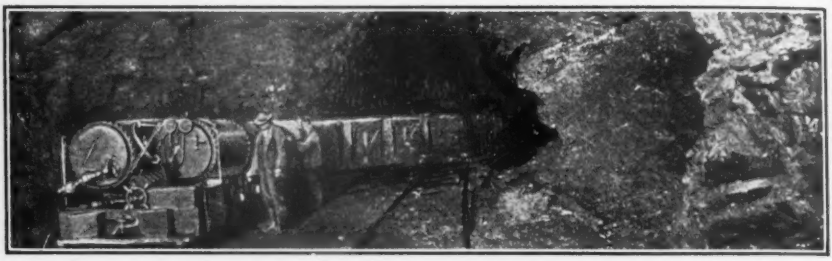

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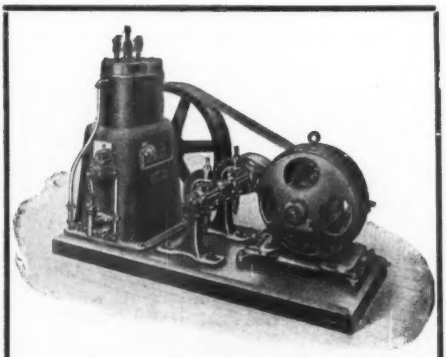

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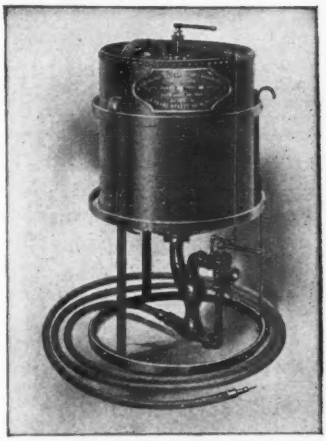

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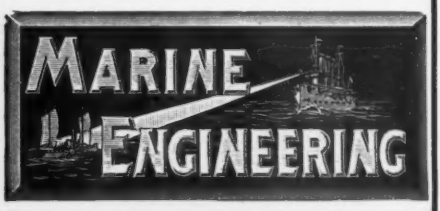

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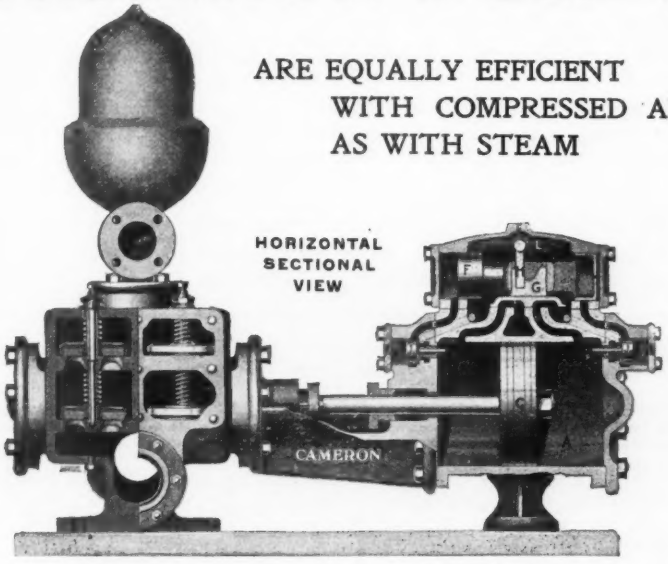

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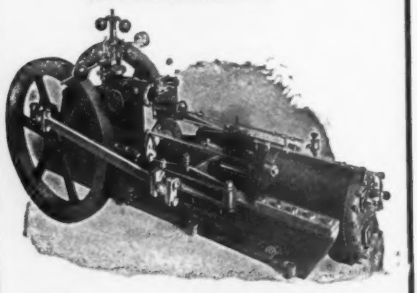

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VOL. X. DECEMBER, 1905. NO. 10

Cool When Attacked by Hot Air.

Mr. John F. Wallace came to New York from the Panama Canal to see his superior officer, Secretary Taft, in order to get his consent to permit him to withdraw from a position which required his personal presence on the Isthmus and to associate himself with the Canal as commissioner, consulting engineer, or in some capacity which Mr. Taft might determine. A service of more than a year on the Isthmus had given Mr. Wallace a knowledge of the subject which could not fail to be of advantage to the Government and this he freely offered. The Secretary, it now appears, judging by his St. Louis speech, had no intention of punishing Mr. Wallace, but he saw an opportunity to make an example in high life of a man and in this way perhaps prevent further exodus from the Isthmus. It will be recalled at about the time of the Taft-Wallace controversy the yellow fever scare was at its height and desertions were frequent.

The Secretary and Mr. Wallace had a stormy interview in New York, the matter was published in full in the papers, and the guns of the United States Government were turned upon the Chief Engineer in a manner which would have annihilated almost any one except this sterling gentleman from the west. Every one expected Mr. Wallace to reply to the attack by making serious charges against the Government, but instead of doing this he said nothing beyond a moderate statement of his side of the case. In other words, he rose above personalities, took his medicine like a man, retired to the golf links of his Chicago country club and calmly said to himself, "I have done nothing of which I am ashamed. I have been unjustly treated and I shall wait until I am vindicated by the natural course of events." This vindication came sooner than one would naturally expect.

The Board of Consulting Engineers requested Mr. Wallace to appear before them and give his views. He complied when it was known that this request was officially sanctioned by Mr. Taft. After the testimony was given the Secretary came out like a man, called Mr. Wallace "a gentleman and an able engineer" and voluntarily modified his attack upon him. The incident is, therefore, closed and Mr. Wallace is reinstated in administrative favor. He has never lost his position in the engineering world, which has regarded him as a distinguished member of its organization and as one who had been sacrificed in an effort to make the practical work of building a canal appear in a chimerical sense as a patriotic duty.

Electricity vs. Compressed Air for Mine Operations.

(FROM THE ELECTRICAL POINT OF VIEW.)

Compressed air has been the recognized medium for the transmission of power in mines for a good many years, and its

use for such purposes has been growing very rapidly during the last few years, so rapidly indeed that a large number of engineers and mine operators probably believe that no other power will ever be able to displace it. It is the intention of this article to dispute such a theory and to show how many and varied are the advantages which electricity presents over compressed air when adapted to this purpose.

Probably no one would care to contradict the statement that electricity is more economical to produce. The losses in modern electrical generators have been reduced to a minimum, while losses in air compressors, although greatly reduced within the last few years with modern two-stage machines, form still a comparatively large percentage of the total power of the machine.

It is in the transmission of the two mediums, however, that electricity presents its great superiority. The total losses in an electrical circuit are represented by a drop in the potential of the line and seldom exceed one or two per cent. in installations involving comparatively short distances. With compressed air installations, however, the transmission losses usually represent a large amount of power and increase at a rapid rate with the number of elbows, valves and pipe lengths which are used. There is no increased drop from the effect of sharp turns in electrical installations, while with compressed air systems each elbow and valve represents, approximately, the addition of an entire length of pipe to the system. Besides this there are nearly always large leakage losses and a great increase in the expense of installation, since wrought-iron pipes, with the necessary valves and fittings, are an expensive proposition to install and keep in repair.

One of the important advantages claimed for compressed air in mines is that the exhaust air may be used for ventilation. Let us examine this carefully and see how much of an advantage it really amounts to. In the first place, the writer wishes to quote from the report of the Miners' Phthisis Commission of the Transvaal, as follows: "The composition of compressed air, shown by analyses, has revealed the very great danger that attends the use of inferior oils (or oils of low flash point) for the lubricating of the air cylinders of the compressor engine. The analyses of the compressor air show that in some of the samples carbonic-oxide gas was present in sufficient quantity to be extremely dangerous to health." It will be seen from the above that, while compressed air rock drills undoubtedly ventilate the mine with their exhaust air, yet the ventilation so obtained is apt to have an exceedingly bad effect on the health of the workmen. Furthermore, ventilation obtained in this way is about the most expensive proposition that one can well imagine; it means that air under from 60 to 80 pounds pressure is allowed to escape into the mine for ventilation purposes, while, as a matter of fact, air under the pressure of a few ounces would do the work just as well and would be far better for the health of the miners. It is a well-known fact that the modern compressed air rock drill does not use air expansively, in fact, it is an impossibility for it to do so without freezing up the exhaust ports. This being the case, it means that air which has required a large amount of power to compress is being practically thrown away when it possesses a potential value represented by the amount of work which it would do if expanded to atmospheric pressure. A small electric blower, requiring less than one-thirtieth the power required to operate a 3-inch rock drill, will effect all the ventilation which would be accomplished by the exhaust air from the drill.

Aside from the fact that an electric rock drill does not waste a large amount of power on so-called "ventilation," it possesses advantages in the way of lighting which are of considerable value, it being possible to connect incandescent lamps to the same circuit which is furnishing power to the drill.

Another drawback to the compressed air drill, and one which is probably least understood, is the fact that it requires increased power to compress, at an altitude, an amount of air which will be equivalent in effect to a given amount at the sea level—the amount of increase averaging about 2 per cent. for each 1,000 feet of altitude. This is an item which ought to appeal to owners and operators of western mines, which are usually situated at considerable altitudes, and provides an excellent argument for the use of electrically operated rock drills.

In general, it might be said that a 3¼-inch electric drill will only consume from 2½ to 3 horse-power against 15 horse-power for an air drill of the same size. Taking into consideration also the fact that electricity is more economical to generate and transmit, it would seem as though there ought to be a large field for its use in the mining industry in the future. The very fact that it has driven everything before it in the industrial field ought to be proof enough of its fitness for work in mines and quarries.

W. R. HULBERT, M. E.

"Electricity vs. Compressed Air for Mine Operations."

(FROM THE COMPRESSED AIR POINT OF VIEW.)

In recent editions of various technical journals appeared an article on "Electricity vs. Compressed Air For Mine Operations," by W. R. Hulbert, M.E. In this paper are presented in brief the advantages of electricity over compressed air for mining purposes. It is claimed that electricity is cheaper to produce, especially at altitudes, that the transmission losses are less than in an air plant; that the dangers and expenses attending the uses of compressed air are great and that electricity has the decided advantage of being serviceable for the purpose of lighting.

It is my purpose to refute these arguments.

Of course, it is well known that when two or more systems are available for accomplishing an end, each system has certain advantages not possible in the other. Such is also the case with the electrical and compressed air systems.

Regarding the first cost or the cost of installation, the advantages are much in favor of compressed air. As far as boilers and engines are concerned each system calls for about the same investment; the equality of costs stops at this point. It is well known that the cost of installing a dynamo is greater per horse-power than for installing a compressor, and as the units decrease in size the first investment per horse-power increases, and furthermore the price of alternating current machines is in excess of that of direct current generators.

If alternating current is used and if the current must be sent some distance, transformers are necessary on either end of the line, and if direct current must be the working fluid at the tools, a convertor is needed. It is thus seen that the number of units which comprise an electrical system are great, and that as the number of units increases the investment cost must correspondingly increase. The advantage is, therefore, greatly in favor of the simple compressed air system. The latter requires for its economical operation a compressor, a good pipe line and only one possible accessory in the form of a reheater.

As the number of parts of a system of generation increases, the cost of maintenance and repairs increases also. Interest and depreciation likewise are important factors.

Altitude compression, due to the more varified conditions of the atmosphere, is accompanied by a slight increase in horsepower over that necessary at sea level to produce the same results at the tool. This calls for the employment of a somewhat larger compressor. Even the additional cost of this larger machine still leaves much, as far as the costs of installation are concerned, to the advantage of a compressed air system.

Beginnig with a steam engine, is it cheaper to produce electricity or compressed air for mine operations? Taking the available energy in the steam engine as unity for both systems, we find that in transforming the work into electrical current at a certain potential there is an attendant loss of about 10 per cent. under good conditions; these losses are due to friction, hysteresis and magnetization. It is granted that the energy gotten out of a compressor is less than that secured from a dynamo, but the difference is slight. The losses in the compressor are due to both the friction of parts and to the thermodynamic requirements. The latter loss arises from the fact that compression under pure isothermal conditions is impossible. Since the jacket water cannot remove the heat generated by compression as quickly as the ideal would warrant, actual compression lies between the isothermal and the adiabatic. These losses decrease more and more as the number of stages for compressing the air is augmented. At the power station we still have the advantage in favor of compressed air, for at this point a reheater may be employed and with very slight

additional cost for fuel, the energy of the air may be so materially increased as to eclipse the advantage of electricity, leaving much economy to the credit of compressed air.

Transmitting any energy necessitates losses. Electrical current flowing over a conductor must necessarily decrease in intensity as the distance from the power station becomes greater. This drop depends directly upon the quantity of current passing through the conductor and also upon the length, diameter, and quality of the wire. The energy lost in friction or resistance is expressed by

$$W = I^2 R$$

and the loss is seen to increase directly with the square of the current and directly with the length of line. Resistance varies with the length of conductor and inversely as the diameter. To diminish, therefore, the watts lost in friction, either the current or the length of line must be decreased or the area of the wire increased; the first two conditions are impossible, since the machine to be operated must have and will call for a required operative current and since the length of line depends upon the distance of the power house station from the work. The only alternative left open to us is to increase the diameter of the conductor. Those who are at all familiar with copper costs can readily appreciate the great expense that this would entail. In fact, there are instances where electrical energy is transmitted some distance under moderate voltage in which combined costs of the copper, poles and porcelain insulators was almost as great as that of the installation of the power plant proper. Of course, the resistance losses due to transmission may be decreased by sending power over the line at high voltage. This calls for alternating current, that the generated energy may be transformed at the power station to a current at high potential.

Neglecting the phase relations, the pressure of a line is known to vary according to the law:

$$E = I R$$

and the energy according to the formula:

$$W = E I$$

If E and I represent the voltage and amperage at the power station, and E^1 and I^1 those at the operating station, then neglecting line losses:

$$W = E I = E^1 I^1$$

As the potential at the power station is increased, and since the products of the volts and amperes must be constant, the current must decrease. A transformer accomplishes this, giving a light current flowing at high potential attended with slight losses. These losses may be increased to reduce the copper cost by decreasing the diameter of the conductor and increasing the resistance of the line. In fact, with an alternating current, we may secure with thin wire a copper loss no greater than that gotten with best conditions when employing direct current, but the use of alternating current necessitates the introduction of extra machines. We generate at the power station alternating current at normal voltage; this is raised by a "step-up" transformer which has an efficiency of about 90 per cent. to 95 per cent.; the current at high potential is sent along the line with small copper losses until it reaches the place of application. At this point a "step-down" transformer must be employed with its attending losses to bring the voltage to a safe amount for operative purposes. If the electrical tools call for direct current, as is generally the case, a rotary converter is needed to transform the current from alternating to direct. This transformation necessitates a considerable loss.

In transmitting compressed air, we find different laws governing the losses. As the air flows through the pipes, the resistance of the inner surfaces must be overcome, and this gives rise to a slight drop in pressure. Compressed air differs from electricity especially in this—electrical friction losses cannot be regained while corresponding losses with compressed air may be eliminated. The moderate fall in pressure in the air due to friction augments the volume of the air and does not involve a loss of transmission. "If the air were at 80 pounds gauge or 95 pounds absolute upon entering the pipe and 70 pounds gauge or 85 pounds absolute at the other end, there would be a loss of a little more than 10 per cent. in absolute pressure, but at the same time there would be an increase of volume of 11 per cent. to compensate for this loss of pressure and the loss of available power would be less than 3 per cent."*

At the point of application of the air the initial energy may be restored by adding a slight amount of heat to the

* "Compressed Air Information."—Saunders.

air; in fact, the employment of a reheater increases the volume to such an extent that additional energy is gotten when air is used expansively at a rate of 1 *horse-power per pound of coal.*

In mine operations, not to interfere with the comfort and health of the men, the reheater is never pushed for all that it is worth. Compressed air is only raised in temperature slightly to make up for the transmission drop in pressure. Thus it is apparent that the loss of energy in transmitting air is nil; even when a reheater is not used, the drop in pressure and the loss of energy is slight as compared with electrical transmission losses, with the advantage in favor of compressed air.

Electricity has the inherent difficulty danger to the operator. The insulation may be defective and the effect of shock may prove fatal. Where electricity is employed for mine haulage a third rail or live wire is needed, and for apparent reasons no insulation whatever is used. The only safeguard possible are signs reading, "Danger! Don't Touch the Wires!" What guarantee from accident are mere signs? How often are live wires touched unintentionally? How great is the risk in the low headings of the mines? How can printed warnings be of service to many illiterate miners, especially those of foreign birth? Furthermore, if anything should happen to the source of power, the motors used on the cars or cages would stop and cause them to become inoperative; with compressed air, however, there is energy enough stored in the receivers to permit the cars being raised to the surface. The risk attending the use of electricity in a gaseous mine is obvious. Some recent mine explosions have occurred in mines supposedly non-gaseous. These facts in themselves should preclude the use of electricity in such places. Under all mining conditions is compressed air entirely safe, and it may be handled by the most careless and most ignorant with absolute confidence. Any leak in the compressed air line assists ventilation, as do exhausts from all the tools; it reduces the effect of poisonous gases and dilutes or expels the smoky products of blasts.

The ventilation secured from compressed air is of itself an extremely costly process. As a matter of fact, however, no expense at all is involved, as the ventilation is gotten from a waste. There is an instance on record where the exhaust air was of a noxious character; this was due, undoubtedly, to the bad practice of employing a poor lubricating oil in the compressor cylinder. Of course, such conditions should be guarded against, but they are apparently so rare as to cause no alarm.

Electricity has *one* advantage over compressed air. Electricity may be employed for lighting a mine and lighting a mine with compressed air is impossible. But who needs light throughout? Few lights are necessary, and those only at certain points. Were electricity employed for lighting purposes, it would, nevertheless, be the best practice to have the lighting system independent of the power system that the lines may be intact in cases of emergency. As a matter of safety, the old form of miners' lamp has the advantages on its side. Explosions are impossible, and the light is always with the operator just when needed.

Electricity has advantages which are possible with no other form of energy, but for mining purposes compressed air far surpasses it as a driving fluid. Were the cost of installation, generation and transmission of compressed air greater than that for the electrical system, the fact of the danger in employing electricity should certainly preclude its use. Compressed air stands alone in this field of operation. It is cheap, reliable, safe and effective.

EDWARD F. SCHAEFER, M. M. E.

A New Method of Pumping Sand by Means of Compressed Air.

AT THE PLANT OF THE UNITED STATES SILICA COMPANY.

One of the most unique applications of compressed air is found at the plant of the United States Silica Co., Ottawa, Ill., about 80 miles from Chicago. At this point is an immense deposit of silica sand, very fine, almost snow-white, of the best grade for glass-making purposes. The property of this company at this place has been worked for some years and at present the excavation is about 800 feet long, 600 feet wide, and with a maximum depth of about 100 feet.

The cost of removing this sand and hoisting to the plant on the surface has

been steadily increasing with the depth reached. Recently a point was reached at which a shut-down of the property seemed imminent unless some more economical method of lifting the sand could be devised. In this crisis a contract was placed with the Pneumatic Engineering Company, a department of the Ingersoll-Rand Company of New York, for the installation of a Harris compound displacement pump especially adapted for this particular work. Briefly, this system involves a direct displacement of the contents of a tank by air under pressure, this air being in turn returned to the compressor for recompression. Advantage is thus taken of the expansive force of the air—a feature distinguishing the Harris system from other pneumatic displacement pumps.

In the Ottawa plant a sump was dug in the lowest part of the sand-pit in which a Harris pump was installed, consisting of two steel tanks five feet in diameter and five feet in height. Upon these are mounted the connecting pipes and valves by which the tanks are filled and discharged in alternation. The double air line of 3½-inch pipe leads to the automatic switch and compressor in the engine room on the brink of the pit. The compressor is a Rand Class "C" straight-line, steam-driven machine, running under 80 pounds steam pressure and delivering air at a pressure of 80 pounds at the maximum of the pumping cycle. The discharge pipe from the pump to the sand bin is a 7-inch pipe and the total distance of delivery is about 400 feet, with a vertical lift of 110 feet.

The method of excavating the sand is at present as follows: a constant flow of water which enters the pit on all sides from springs is collected in a sump which is the source of supply for a small duplex steam pump which takes the water and discharges it through a hose and nozzle. The stream is played on the walls of the pit, washing the sand down, and the mixture of sand and water is directed into a box beside the main pump. The pump suction pipe enters this box and the partial vacuum created in the tanks draws the sand and water into the tanks, from which it is discharged by compressed air in the next cycle through the delivery pipe to

PUMPING SAND BY COMPRESSED AIR AT THE UNITED STATES SILICA CO.'S QUARRY, OTTAWA, ILL.

the bin above. The sand mixture varies in quality from one of 5 per cent. of sand to one of 65 per cent. by weight. The average performance of the pump is 50 tons of sand alone raised per hour, or 500 tons of sand per 10-hour day. The work done by the pump will be further appreciated when it is considered that the supply of water entering from the springs is from 300 to 500 gallons per minute, all of which is discharged with the sand through the pump.

It might naturally be expected that the rapid pumping of such an abrasive material as sand would soon destroy the pump mechanism, but after an operation of several months there has been found to be no appreciable wear on this system. On top of each tank there is a check valve preventing the return of the material in the discharge pipe. This is of the simplest form, consisting of a rubber covered ball resting on a ring seat and inspection has shown that while the seats have worn, they have worn uniformly and present the appearance of a highly polished turned ring. The balls themselves show no wear whatever. The pressure controlling valves are located in the engine room above and at no time are in contact with the material pumped.

This system works continuously: during the day it pumps sand and water in mixture; during the night it pumps water alone, keeping the pit empty and ready for resumption of operations on the following day. It is found that the maximum volume of water entering the pit can be handled when the pump tanks are filled and emptied at the rate of about one a minute.

The introduction of this method of pumping simplified the problem of removing the sand in many ways. Its operation calls for three men; the engineer looking after the compressor, who also cares for other machinery in the surface plant; the pump attendant, whose duty it is to see that the flow of sand and water is properly directed to the gathering box; and the hose man who handles the stream of water for removing the sand from the walls.

The sand mixture is discharged from the pump into a receiving bin at the surface where it is allowed to settle; the

UNITED STATES SILICA CO.'S QUARRY, OTTAWA, ILL.

water flows off through a waste-way. This partially dried sand is then removed from the bins and put through the usual process of drying and separating. The operation of the surface plant offers no unique features; but the introduction of this pneumatic system of pumping in the pit has been the solution of a serious problem which was confronting all the sand producers of that section. The illustrations show the interior of the pit with the pump in position and the pipe lines leading to the plant on the brink. A very good general idea of the difficulties encountered and the methods employed may be had from an examination of these photos.

The system which the new method replaces was, briefly, as follows: the work was carried on in three levels; the sand was washed by the hose to the lowest level, or sump, where it was hoisted by a vacuum steam pump to the second level. Here a single outside-packed direct plunger pump lifted it to the third level, from which it was elevated by a scraper conveyer to the bins. The seepage water was handled at night by a duplex steam pump.

All of these pumps were supplied from the surface boiler plant through long steam lines; and the steam and fuel consumption was enormous, due both to the excessive pipe condensation and to the wasteful non-expansive features of the pumps. Furthermore, the whole system was liable to freeze up solid in winter. The depreciation on the machinery involved was very heavy, the plunger pump especially wearing rapidly under the abrasive action of the sand mixture and losing what little efficiency it had. Fuel and maintenance costs were enormous.

With the pneumatic sand lift the only long steam line is the small one to the hose pump. The rest of the system, being under pressure, is proof against freezing, and its freedom from abrasion has already been noted.

LUCIUS I. WIGHTMAN.

Air Power in the Union Pacific Shops at Omaha, Neb.

Compressed air has become as essential in railway shop work as steam for power or electricity for lighting. Hardly a process of locomotive or car building and reparing is not aided by some form of air tool. The air compressor, as the source of power for these pneumatic tools, assumes an important place in the shop equipment.

In the shops of the Union Pacific Railway at Omaha. Nebraska, air power has been carried to a degree of application probably equalled in no other shop of the country; and the extent of its use has made necessary an air compressor installation ranking among the largest for this purpose.

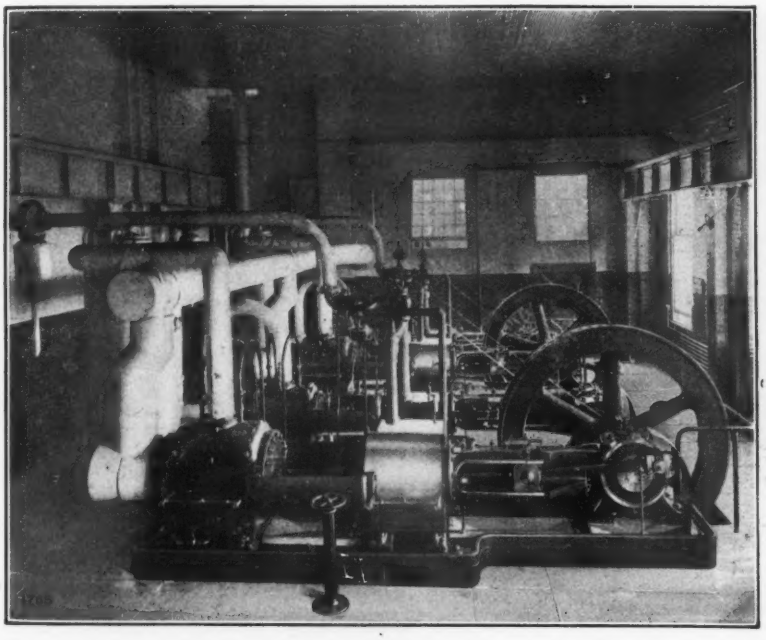
The buildings comprising the various departments of these shops are compactly grouped beside the yards of the company and in their arrangement shop economies have governed. The power house is at the south of the main group and was one of the shop buildings under the scheme in effect before the late improvements and rearrangement. This fact accounts for some features of power house arrangement which differ from usual practice where the building is designed to suit the work. A longitudinal fire-wall separates engine and boiler rooms. The boiler equipment was selected to meet the conditions of very limited space. For this reason it is made up of 6 marine shell boilers, with internal fire-boxes. These units are rated at 250 horse-power each, giving a total capacity to the plant of 1500 boiler horse-power. Hand firing is employed, the coal being dumped on the fire-floor from cars on the side-back paralleling the power house. Steam pressure carried is 150 pounds on the boiler gauges. Boiler room auxiliaries are grouped at the north end of the battery of boilers and comprise the usual equipment of feed pumps, heaters, etc.

The main steam header for the power plant is in the boiler room, in the rear of the boilers. It is subdivided and protected by valves according to the best practice. All engine room exhausts unite below the floor in a header leading to the exhaust head, above the roof. From the steam header, steam pipes to all engine room units pass through the fire-wall and lead to the cylinders through wide-sweep bends. Separators are on each steam pipe just within the engine room, and all steam piping is protected by insulating covers.

The engine room contains two air compressors built by the Ingersoll-Sergeant Drill Company, of New York. They are of duplex pattern, with cross-compound steam and air cylinders. The type is des-

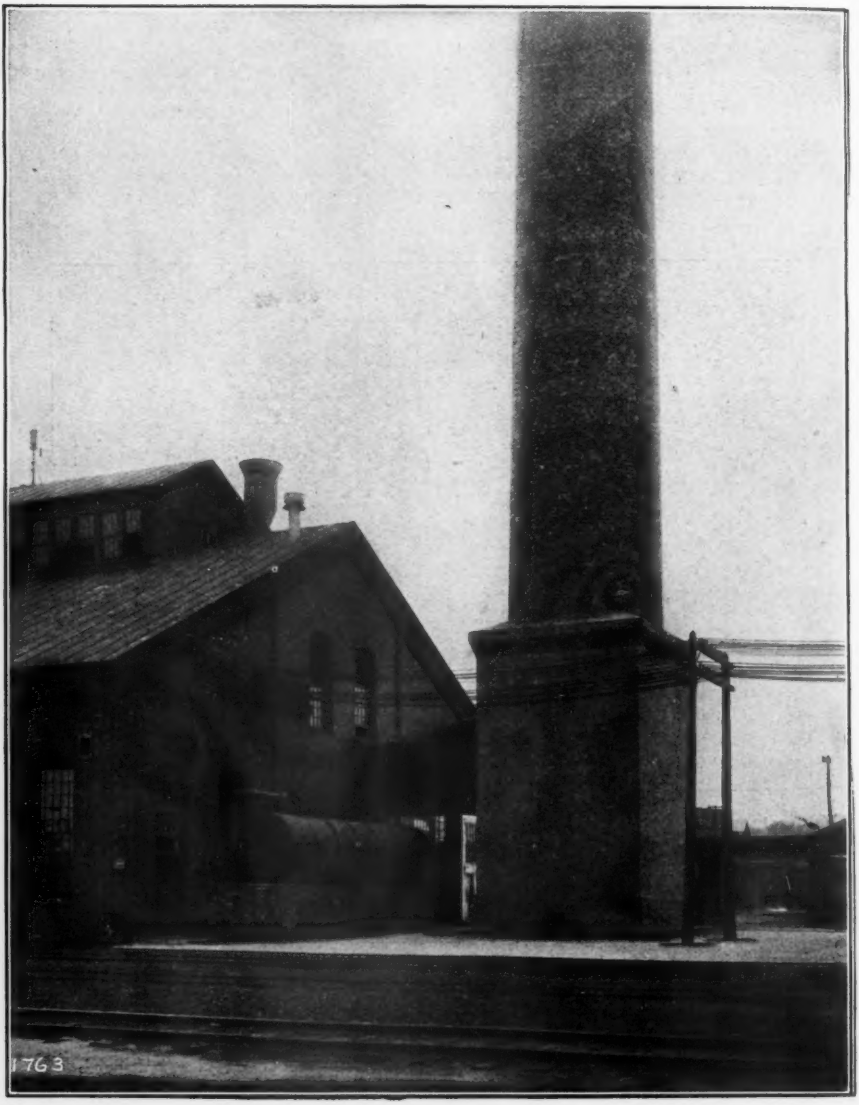
ignated by the makers as Class "GC." Steam cylinders are sheathed and insulated, equipped with Meyer balanced adjustable cut-off valves. A reheating steam receiver between high and low pressure cylinders draws live steam from a by-pass inside the throttle. The standard Sergeant "Air Ball" governor regulates speed and pressure by throttling the steam supply. A by-pass pipe taken from the steam pipe inside the governor leads to the low pressure steam chest. It has a pressure oil, supports the entire compressor on a solid concrete foundation.

High and low pressure air cylinders are water-jacketed on heads and barrels. Both cylinders are fitted with the Sergeant piston inlet valve. Discharge valves are of vertical direct-lift pattern, readily accessible. A somewhat novel style of air intake is used. The inlet tubes of the low pressure cylinders are surrounded by a sheet-iron case, leading to a vertical riser of sheet-steel pipe which connects with a



INTERIOR VIEW OF THE POWER HOUSE OF THE UNION PACIFIC SHOPS, OMAHA, NEB.

reducing valve which ordinarily is closed. But when the governor throttles the steam supply and pressure on the high pressure cylinder reaches a certain minimum, this valve opens, admitting live steam direct to the low pressure cylinder through the by-pass pipe, thus equalizing the work in the two steam cylinders. The main frames are of girder type and main bearings large and heavy. Cranks are of balanced disk pattern. A solid sole-plate, with a rim for catching main intake header carried to an opening outside the engine room on the northeast corner. Traps in the intake casing give easy access to the piston tube and stuffing box. The intercooler of each unit is of vertical receiver type, with tinned brass tubes for the cooling water and an ample air storage capacity. Proper provision is made for withdrawing condensed moisture and the entire intercooler and connecting air pipes are covered with insulating material.



EXTERIOR VIEW OF POWER HOUSE SHOWING PRIMARY AIR RECEIVER.

Each compressor has a free air capacity of 2,216 cubic feet per minute, when running at 120 revolutions per minute. The air pressure is maintained at about 110 pounds on the receiver, giving an average working pressure of 100 pounds throughout the shops. Air cylinders are 16¼ and 24¼ inches in diameter; steam cylinders, 16 and 24 inches. The stroke is 18 inches.

One of the illustrations shows the primary receiver, mounted outside the power house on the north side. Its dimensions are 6 feet by 30 feet, giving an exceptionally large storage capacity. It is properly drained.

The main air pipe passes underground to the shop buildings and radiates to the several departments. All piping in the buildings—air, water and gas—is carried in shallow conduits in the floor with removable covers. Branches with valves rise at each post for connection with shop appliances.

The applications of air in the shops are those common to railway repair work. In the locomotive shop, air drills in various sizes are used for drilling, reaming and tapping; chipping and riveting hammers have their usual place; pneumatic staybolt cutters assist in dismantling fire boxes. A small rotary air motor drives gearing for turning locomotive drivers in setting valves. Another operates a cylinder boring machine. Air hoists and air jacks assist in the handling of heavy parts. Pneumatic presses find a ready place in certain classes of work. In the air brake testing department, air pressure is drawn from the main plant. An interesting device here is a pneumatic pressure coupling which holds the valves under test against the supply pipe, saving the time and trouble of screwing in place.

In the yards, warehouse and foundry air hoists appear on every hand—silently, easily swinging great loads. In the car shops pneumatic drills find manifold uses, and air jacks assist in many operations. Cars are sand-papered, and paint is removed and applied, by air appliances. Practically all cleaning is done by the air blast.

The Hastings Tunneling Shield System.

There are two subjects that have received more than ordinary attention from the engineering profession during the last few years and in that time have undergone a wonderful development. One of them is the construction of tunnels, particularly subaqueous tunnels, and the other the use of reinforced concrete in structural work. Each is and has been a very important line of work, but there has been nothing in common between the two. It has remained for C. G. Hastings, a tunnel engineer of many years' practical experience, to propose an association of the two in a subaqueous tunnel wherein reinforced concrete takes the place of cast iron or steel in the walls of the shell. While the scheme has not yet been put into actual use, its feasibility seems reasonable, and at any rate the idea offers suggestions that make it worthy of investigation.

Whatever may be said of the tunnel system, the tunneling shield with which the inventor intends to construct the tunnel is no experiment, as it has been used with great success in the building of a noted tunnel which is now completed and in use.

The tunnel lining is to consist of metal reinforced concrete, forming an impervious artificial stone, molded into convenient segment blocks. The several parts entering into the construction of the reinforced concrete tunnel walls are shown in the section, Figure 1, which is partly broken to expose them successively. Before taking up the tunnel proper, however, it will be well to thoroughly understand the construction and manner of using the shield.

The tunneling shield, shown in Figures 2, 3 and 4, consists of two concentric cylinders, one inside the other, united at the cutting edge by a series of radial ogee plates. Both cylinders extend from the cutting edge to the rear end of the shield, where they are united by a series of radial perforated segment plates. Intermediate of the ends the cylinders are mutually supported by longitudinal stiffeners. between which is formed a series of compartments, wherein are placed the hydraulic jacks, that are used to advance the shield. These extend through the holes in the segment plates, being secured to them by lag screws passing through the bearing collars of the jacks. Within the hood, which is a continuation of the outer cylinder of the shield, the lining of the tunnel is built up, and to advance the movement of the shield the several

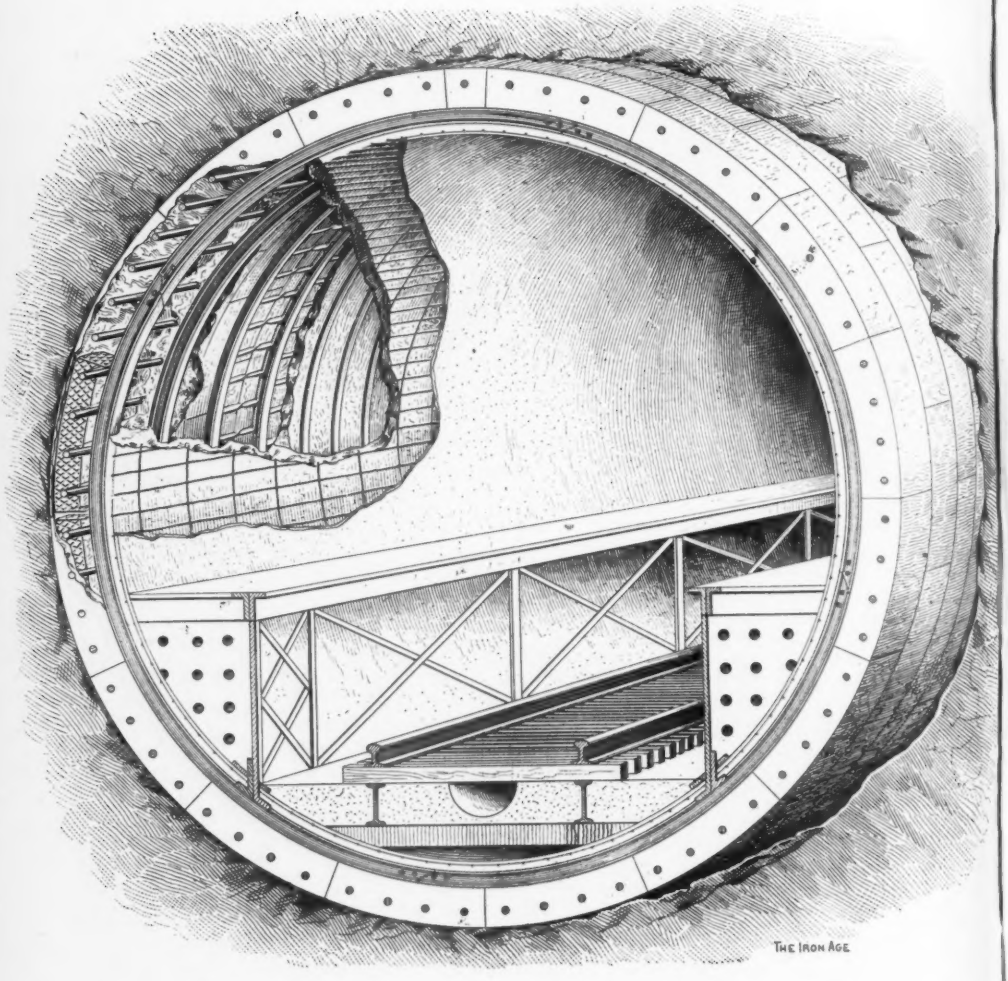


FIG I.—SECTION OF THE HASTINGS REINFORCED CONCRETE TUNNEL.

The Broken Parts Show Successively the Reinforcing in the Molded Blocks, the Circular Beams, Their Tying Connections, the First Coat of Concrete, the Woven Wire Reinforcing and the Finishing Coat of Cement.

hydraulic jacks react against the tunnel lining.

The interior of the shield is divided by vertical and horizontal walls into convenient working chambers of dimensions depending upon the size of the tunnel diameter. The vertical positions are of truss construction and the horizontal partitions of plate metal, all being substantially reinforced by curved steel plates extending rearward from the cutting edge a certain distance to best resist any strains that may be brought to bear upon the partition members. The curved plates are

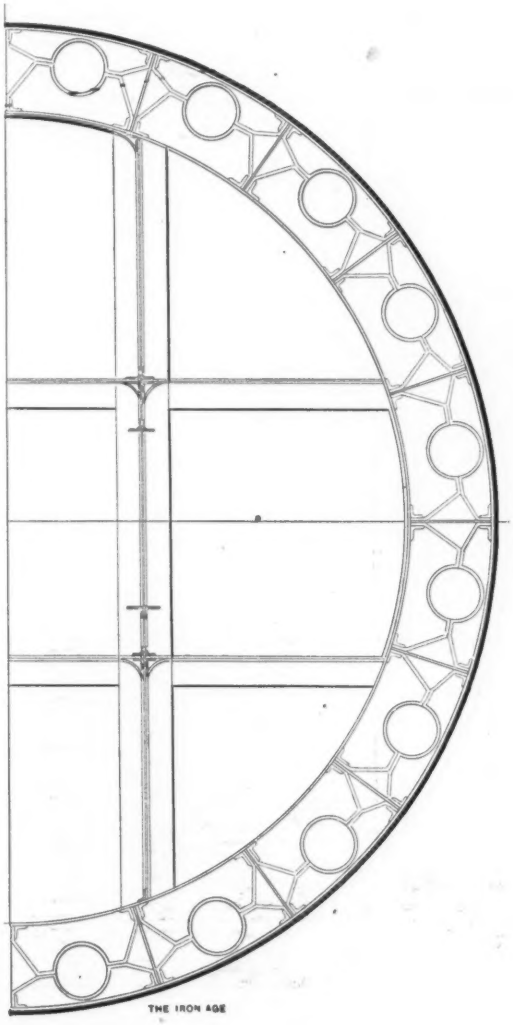


FIG. 2.—HALF TRANSVERSE SECTION OF THE HASTINGS TUNNELING SHIELD.

so arranged as to deflect all soft sliding or inflowing material and to prevent excavated material at the heading from becoming lodged against flat or abrupt surfaces in the chambers. In this manner the material is caused to pass through the shield to the bulkheads, where any treacherous material may be easily controlled. It should be mentioned that the strength of the shield is not dependent upon these dividing walls, as the concentric cylinders forming the shield proper are sufficient in themselves, and when the shield is of small enough diameter to require no more

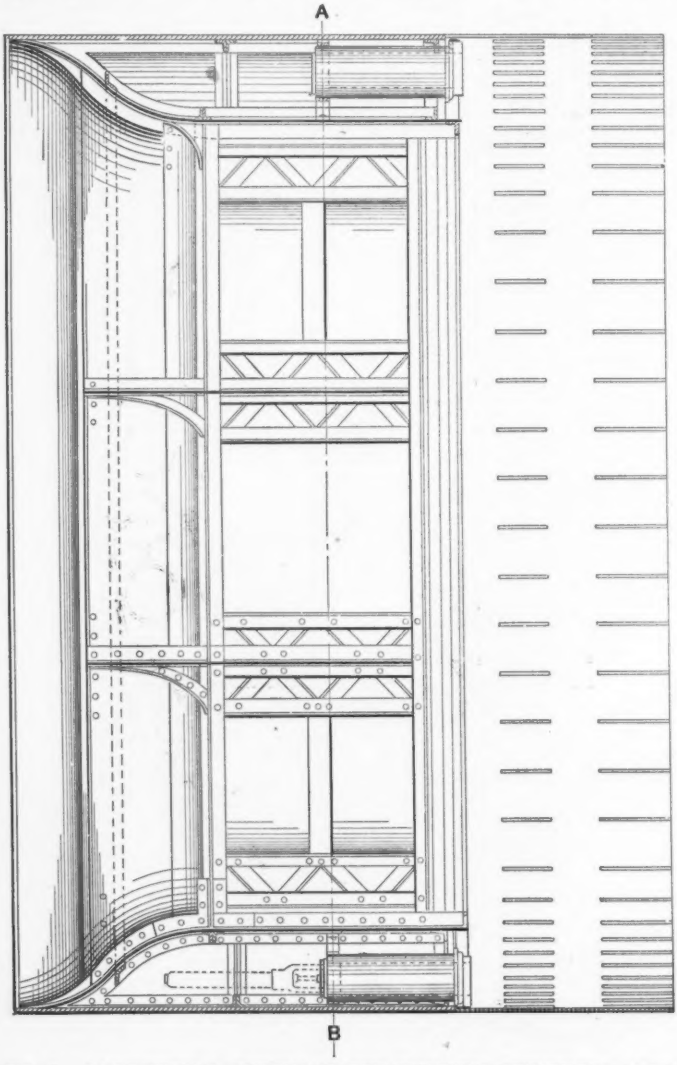


FIG. 2.—LONGITUDINAL SECTION OF THE HASTINGS TUNNELING SHIELD.

than one chamber, the dividing walls may be and have been dispensed with.

The bulkheads are provided with sectional perforated doors carried on heavy hinges, and can be conveniently opened in whole or in part as the occasion or condition may require. If saturated or unstable material is encountered, the doors can be quickly closed in any or all chambers of the shield, leaving the perforations of the doors open for the passage of the material. This permits the continued forward movement of the shield, and so does not arrest the progress of the work.

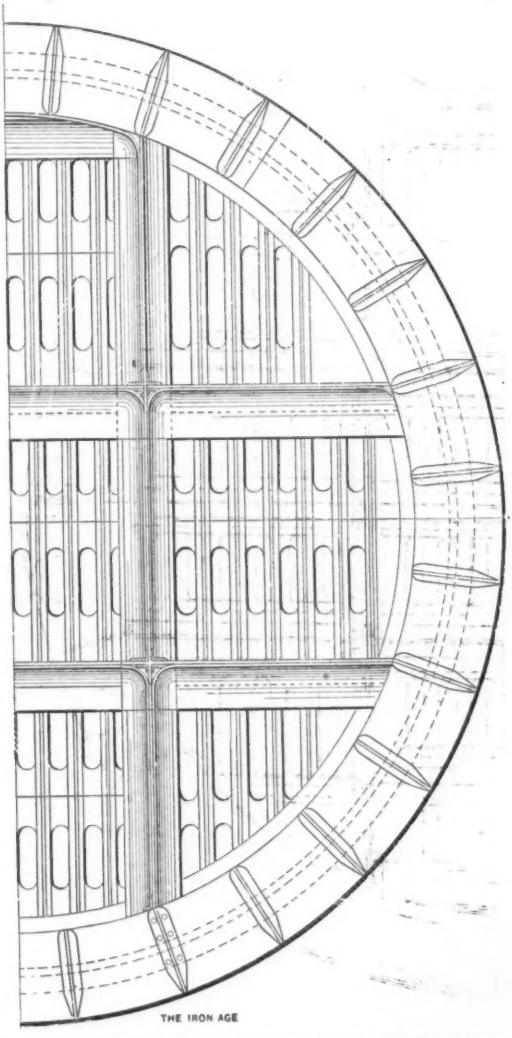


FIG 3.—HALF FRONT VIEW OF THE HASTINGS TUNNELING SHIELD.

If the material outside of the shield is of such an extremely soft character as to flow too freely through the door perforations, which might cause a settlement chamber, independently of the others, or in any part of a single door by sliding gates attached for that purpose, thus arresting the inflow of matter until the

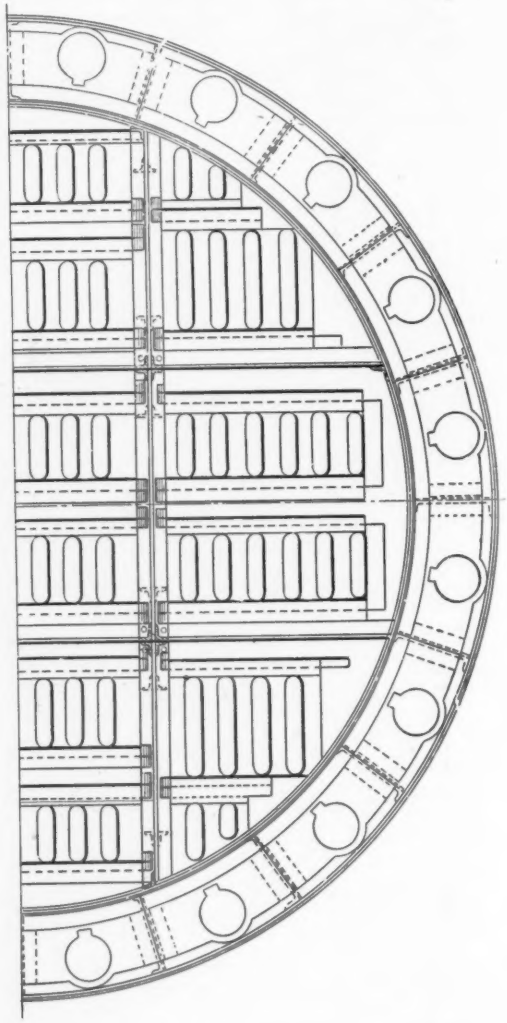


FIG 4.—HALF REAR VIEW OF THE HASTINGS TUNNELING SHIELD.

or displacement of the earth enveloping the outer periphery of the shield, the perforations can be quickly closed in any shield has been advanced into the heading sufficiently to compress the mud within the belled periphery of the shield, where it is

concentrated, and may then be deflected in the regular course to the working compartments and, coming in contact with the sectional bulkheads, may be removed through the doors.

If rock bowlders or other hard material is encountered, the doors in a plane with such material may be thrown open while the obstruction is removed by drilling and blasting. When working in dry clay in a normally safe state, the doors are entirely open for a free and rapid passage of the excavated material.

The rear hood of the shield is designed so thin that the tunnel lining in course of erection conforms very closely to the bore made by the shield and prevents any greater displacement of the surrounding earth than is necessary for the convenience of proper construction. This is particularly of advantage where the tunnel runs under streets or buildings and any settlement would be dangerous. Moreover, it insures a more uniform load on the tunnel and removes very largely the likelihood of later deformation.

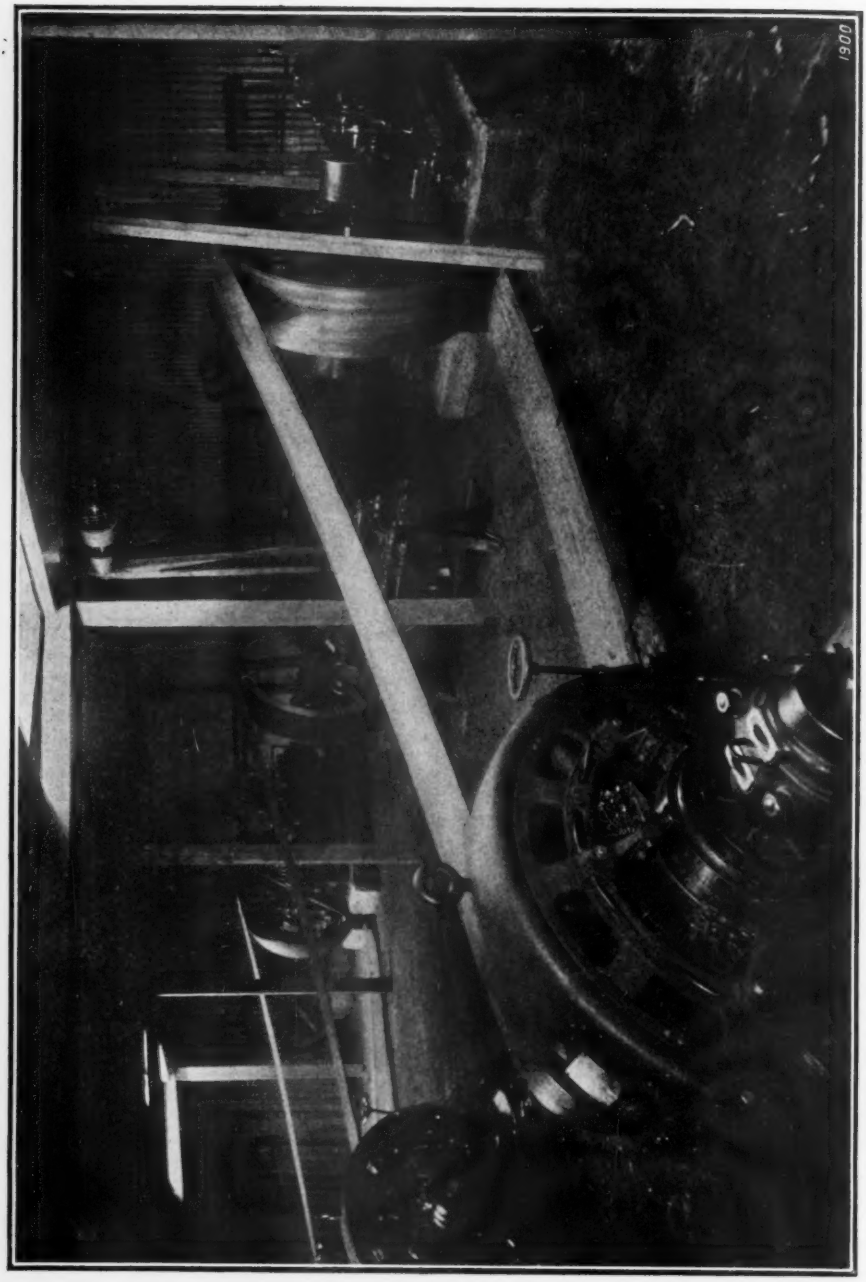
It may be seen that the elementary features of the Hastings shield are of a practical character, well adapting it to working where the conditions which will be met with cannot be definitely determined in advance, as in most underland and submarine construction. Its practicability through a soil of varied character was demonstrated when it was used in the construction of 4,139 feet of 24 foot 9 inch bore on the main conduit of the Chicago intercepting sewer system. The strata formation consisted of varying materials, one underlying the other on the part of the work, while on another section the work passed entirely through running gravel and saturated quicksands.

The impervious reinforced tunnel lining has for its foundation structure a series of metal reinforced segment blocks molded into a crystallized mass by an improved method without the use of tamping or pressure. The reinforcing is imbedded in proper positions to distribute the strains to which it is to be subjected. There are also imbedded in the concrete blocks appliances to assist the work of erection. Each block is placed in position by a rotary segment hoist connected with the shield, and pressure is brought to bear upon the blocks to force them into proper position by the hydraulic jacks which shove the shield forward. Elastic waterproof pads are inserted in all circumferential and abutting joints of the blocks to aid in imbedding each ring of segments in perfect conformity with the erected work and to render all seams waterproof. A coating of waterproof material is applied to the inner surface of the segment blocks when each ring has been completed, after which a reinforcement of circular steel beams is placed in position. There is one beam to each ring of blocks, which is secured to them by appliances molded in the blocks at the time they are made. The circular beams are reinforced and stiffened by connecting longitudinal bars of special form attached at equal intervals around the circumferential beams. A suitable distance from the inner periphery of the beams and their connecting bars is placed a cylinder of expanded metal in spiral form or a netting of heavy steel wire, such as Page woven-wire fencing. The inventor favors the latter as having some advantages over expanded metal. Over the netting is applied a homogeneous coating of cement concrete, completely imbedding all the metal reinforcement. The interior surface is then troweled to a smooth finish.

This system of concrete tunnel construction is recommended for tunnels for railways or traffic purposes of any kind, and is claimed to be of extreme durability and of decidedly moderate first cost as compared with tunnels made in accordance with present day practice. The inventor, Cornelius G. Hastings, has secured patents covering the essential parts of his inventions for the United States, Canada and Great Britain, and has other patents pending applicable to construction work of a mechanical and civil engineering nature.—*The Iron Age.*

An Air Power Plant for Pneumatic Tool Service.

There were 100 steel cars to be built for the London Metropolitan Railway when it was decided to convert the system to electric power. The contract for these cars was secured by the American Car and Foundry Company, under conditions demanding the highest possible speed of construction; and this very fact called for the best of tools and most up-to-date manufacturing equipment. The work to be done called for a great number of pneumatic tools; and since the



INGERSOLL-SERGEANT CLASS "JC" DUPLEX COMPRESSOR IN THE POWER HOUSE OF THE AMERICAN CAR AND FOUNDRY CO.

contract covered only a short period, the plant installed was necessarily temporary in character.

The order for the complete pneumatic equipment was placed with the Ingersoll-Sergeant Drill Company, of New York and London, and the appliances furnished are of the company's standard types. The tool equipment proper included eighteen 8-inch and twenty-five 5-inch Haeseler riveting hammers and sixteen No. 7 and twenty-four No. 12 Haesler rotary drills, eighty-three in all.

The illustration shows the air compressors, four in number, which furnish power for these tools. They are of the builder's class "JC" duplex two-stage machines of balanced type, with a heavy inside flywheel, solid sub-base, and semi-tangye frames. Air cylinders are completely water-jacketed on heads and barrels, while an intercooler in the sub-base beneath the cylinders provides inter-stage cooling at high efficiency. The Sergeant Piston Inlet air valve is applied on both cylinders and discharge valves are of vertical lift direct-discharge pattern. At rated speed of 150 revolutions per minute, each compressor has a displacement of 526 cubic feet, giving a total free air capacity to the plant of 2,104 cubic feet per minute, which is delivered at a pressure of 80 pounds. Each unit is belted to a direct current British Westinghouse motor rated at 110 horse-power on 550 revolutions per minute. Standard automatic choking controllers on the compressors maintain pressure and regulate output as load varies.

The picture shows the temporary nature of the plant—the cheap shell-like building, the unfinished foundations, the rough earth floors. But it will be noted that every detail has been provided for in the machinery equipment which would assure economy of operation and reliability in service.

Pipe Tunnel at Dover Street Bridge, Boston.*

The ease with which work has been performed of late years under compressed air has led to the substitution of tunnels in place of the old style heavy pipe siphons, where the pipe, being imbedded in concrete and once sunk in place, is inaccessible for repairs.

One of the Boston siphons was wrecked a few winters ago, and several narrow escapes from similar accidents have been observed, and in view of the fact that it was proposed to widen the channel at

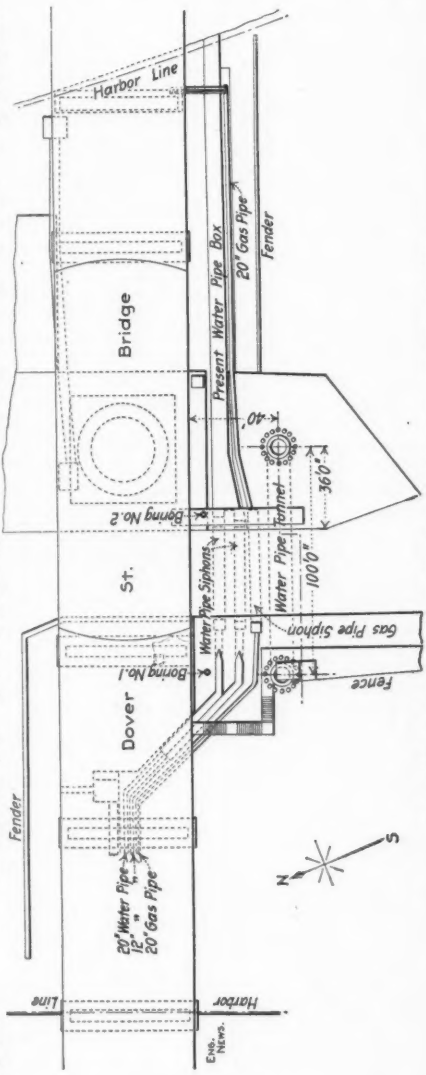


FIG. 1.—PLAN OF WATER PIPE TUNNEL AT DOVER ST. BRIDGE, BOSTON, MASS.

* By Frederic I. Winslow, Assistant Engineer, City of Boston, in the *Engineering News*.

Dover Street bridge, thus throwing out of commission the two siphons there, carrying a 12-inch and a 20-inch pipe, it was decided to construct a brick-lined tunnel, 8 feet internal diameter and 100 feet between centres of the shafts, Figure 1.

Circular fenders were constructed around the sites for the shafts, and work was commenced Jan. 1 of this year, the fenders being finished Feb. 19.

The cylinders or shells for the shafts were constructed in two lengths, of 20 and 12 feet respectively, the longer length being sunk first, and the shorter one bolted to it. These cylinders were 10 feet in diameter, and 3/8 inch in thickness.

The elevation of the bottom of the lower cylinder was 83.0 above datum. The cylinders were lined with 16 inches of brick before being lowered, excepting a small section near the top, which was lined just previous to letting on the air.

The air-lock, which was 6 feet in height and the same in diameter, proved to be a very comfortable chamber in which to "take air." The lock was bolted to a diaphragm which was bolted to the top of the upper cylinder. This left a circular ring, which was utilized for the insertion of wire for the transference of the lines for the tunnel from above. Air was put on on Feb. 23, and excavation promptly began.

A depth of 6 feet below the bottom of the cylinder was excavated and lined with brick, and this process was repeated until the grade of the bottom was reached.

No borings were taken at the exact site of the tunnel, but at points about 40 feet away. The material excavated began with silt, followed by yellow clay, and then a fairly stiff blue clay.

Throughout the work the men worked in shifts of 11 hours each, and after the horizontal portion was fairly begun, a speed of 5 feet per day of finished tunnel was made. The lining was but 1 foot in thickness in the horizontal section, although in general the limits of excavation as shown on the drawing was exceeded; this extra space being filled with masonry.

But one cave-in occurred, when a portion of the roof 10 feet in length and for 5 feet above the roof level came in, but without injury. A length of 10 feet was taken out at a time, the roof being held by thin plates supported by posts, removed as the work of laying brick progressed. No shield was used.

The material in general was a fairly stiff blue clay with sand seams. To reduce the permanent leakage to a minimum, a specially fine sand was used, resulting in a leakage at the present time of 200 gallons in 24 hours, although on a warm day this has been as low as 24 gallons. The joints were calked, after they had set, with an ordinary calking tool, and the entire surface of the tunnel was plastered. No waterproofing material was used.

The distance between the top of the tunnel and the bottom of the channel is 17 feet.

The air pressure maintained varied from 18 to 24 pounds; but one compressor being in service, excepting for a short time toward the end of the work.

An interesting feature of this work was the demonstration of the ease and practicability of "taking the air" rapidly, one minute being all that was usually taken, unless the workmen were suffering from a cold. This tunnel is intended to carry a 16-inch and a 24-inch water-pipe.

The contractor was Mr. Chas. A. Haskin, and the work was done under the supervision of Mr. William Jackson, city engineer; the engineer in charge being Mr. F. A. McInnes.

Westinghouse Compound Pump.*

The new design of Westinghouse compound pump consists of three cylinders placed vertically in tandem. The two lower ones, joined by a thin centre piece, constitute the air end of the pump, and these are surmounted by a centre piece and steam cylinder of the regular Westinghouse type, so that in general appearance this new pump, although somewhat longer, is very similar to the regular Westinghouse pump. The design is very compact and, since the air end only is compound, the additional features required are so similar to the old standard that the same simplicity of operation is assured.

Generally speaking, the compounding of the air end is done as follows: The two air cylinders are of the same diameter, each having a piston suitably connected to the piston rod which is actuated by the steam piston. These two air pistons are further connected by a drum of smaller diameter than the inside diameter of the air cylinders in such a manner that the

* By F. H. Parke, in *The Railroad Gazette.*

two pistons and drum form a sort of spool. The centre piece between the air cylinders fits closely about the spool and has packing rings to prevent the passage of air from one cylinder to the other past the surface of the drum. The low-pressure air is drawn into the top of the upper cylinder and the bottom of the low cylinder and during compression is forced through suitable valves and passages to the annular volume formed between the spool, air-cylinder walls and centre piece. The final compression takes place in this annular volume and the air is forced out through the passages and valves in the centre piece to the discharge opening. It will thus be observed that in each air cylinder both high and low pressures are single-acting, but that these pressures on the air piston as a whole are double-acting. The resultant effect, therefore, on the steam piston rod is almost the same as in the simple pump, but the air cylinder surface being twice as great as in the simple pump affords twice the opportunity for radiation of heat, and for that reason the temperature of the air discharge is considerably reduced for locomotive service.

Also by thus compounding the air end a much smaller steam cylinder can be used to operate the pump, thus causing a marked economy in steam consumption.

The present design of pump consists of a steam cylinder 8 inches in diameter by 12-inch stroke, and two air cylinders 11 inches in diameter by 12-inch stroke, while the small diameter of the spool is 8¾ inches. It is made for a capacity similar to that of the standard 11-inch pump, which has been on the market for some years, having air and steam cylinders each 11 inches in diameter by 12-inch stroke. Consequently the compound pump has an 8-inch diameter cylinder instead of an 11-inch as with the standard, and the steam consumption is thereby reduced to about 52 per cent. of the latter through this change alone. But by compounding the air end the capacity of the pump is increased about 16 per cent. when pumping against 90 pounds air pressure, due to the fact that the low-pressure clearance volumes at the end of a compression stroke are filled with air at only about 40 pounds pressure instead of 90 pounds, as in the simple pump, and in the former case this pressure reduces to the atmospheric pressure much earlier during the intake stroke

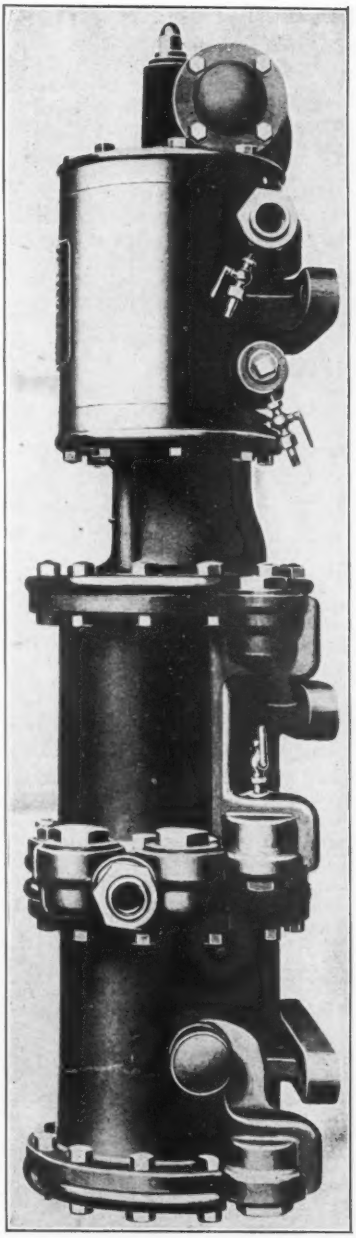


FIG. I.—WESTINGHOUSE COMPOUND PUMP.

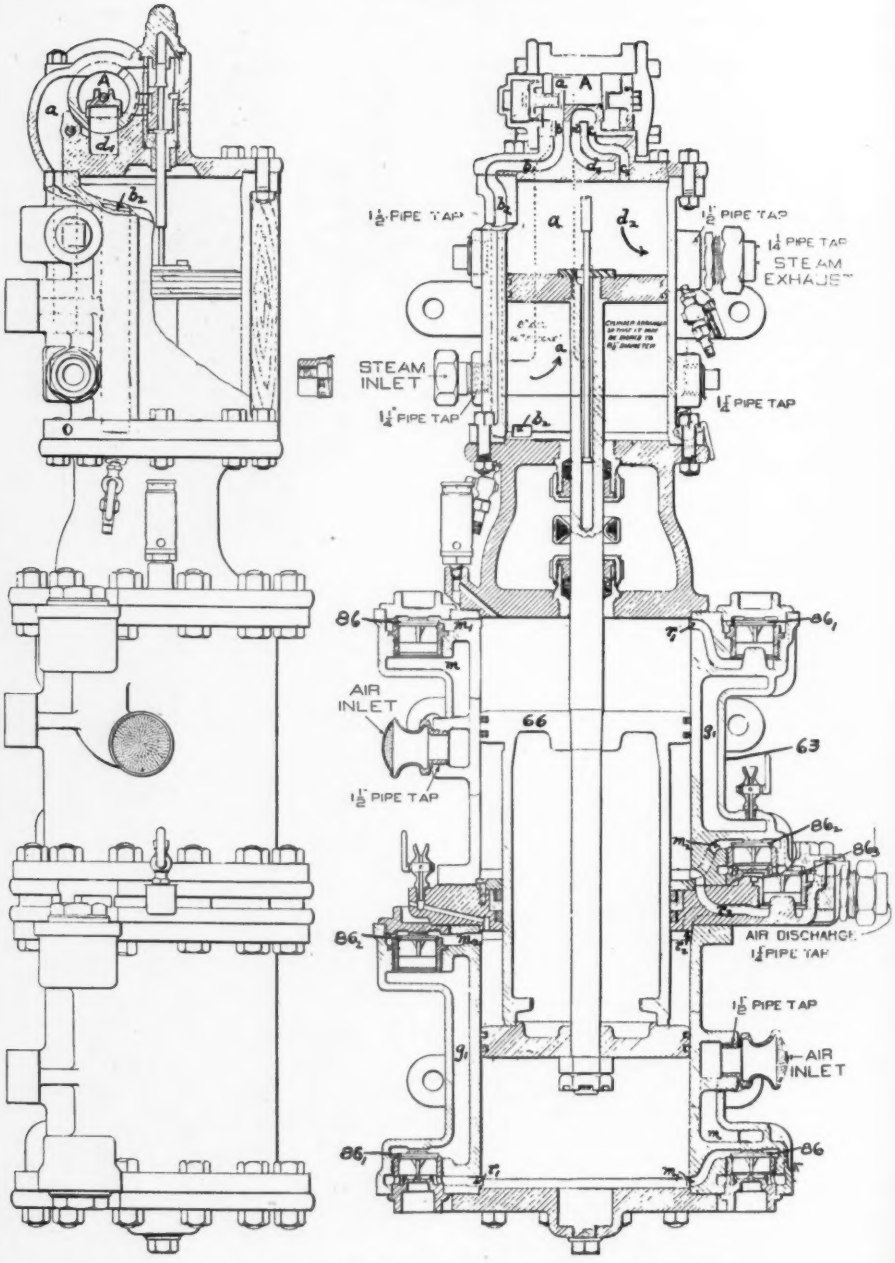


FIG. 2.—SECTIONS THROUGH AIR AND STEAM CYLINDERS.

than is possible with the standard pump, consequently the volume of air drawn in at each stroke is that much greater. For this reason the saving per cubic foot of air compressed is greater than that shown by the difference in steam cylinder volume, and from tests made on the compound pump it appears that it requires only about 45 per cent. of the steam per cubic foot of free air compressed that is required for the standard 11-inch pump.

This, of course, is an immense saving of itself. But since the amount of air compressed per stroke is greater, the time required for the pump to operate is thereby diminished and the amount of wear and cost of maintenance are correspondingly decreased.

The air valves, valve seats and valve cages are of the same pattern as those used in the 11-inch pump, while the steam valve mechanism corresponds exactly with that of the 9½-inch pump. Also the piston rings of the two air pistons are similar to the 11-inch pump and the steam piston rings correspond to the old standard 8-inch pump, many of which are still operating on railroads. The steam and air connections are also made up of standard pieces that are now in use on the other pumps, so that by the introduction of this new compound pump the amount of repair stock required outside of that already needed by railroad shops is very small.

Since the working parts are all modeled after those of the existing standards, the knowledge possessed by repair men at the present time will serve them in making repairs on the new pump without any extended extra instruction. The rules already issued for operating air pumps will in nearly all cases apply to the new pump, so that its introduction, in almost every way, will cause no trouble or inconvenience to the operating departments.

The greatly increased weight of cars demanding larger brake cylinders, together with the greatly increased length of trains, has brought about the expenditure of a much greater quantity of air and naturally the requirement of a larger air pump. It was this fact that brought out the 11-inch pump. With the introduction and general adoption of the high-speed brake and high-pressure control apparatus, the main reservoir pressure was increased from 90 to 120 pounds. Consequently the work of the pump was greatly increased, and the consumption of steam by the air pump has been found to be a considerable factor of importance; and the introduction of an air pump designed to give the greatly increased amount of air, and at the same time require a much less amount of steam, has been made a necessity which both the railroads and the Westinghouse Air-Brake Company have for some time past recognized.

The illustrations will give a clear idea of the design and operation of the pump. The front view of the pump shows the general arrangement. It will be noticed that the steam cylinder is made both right and left hand so that the steam and exhaust connections can be made on either side, or both on one side. The lower thin centre piece connecting the two air cylinders contains the final discharge valves and orifice. Each air cylinder has a suction strainer through which the air is drawn into its low-pressure volume.

Figure 1 is a side view of the pump, showing the position of the air valves and ports, as well as the lugs for supporting the pump in position.

Figure 2 shows a front central section of the pump and a side view partly in outline and partly in section. From this drawing the operation of the pump can easily be followed through. Steam enters from the governor at the steam inlet and passes through the valve; from thence it goes to either the top port, *a*, *a*, to the cavity *A*, over the main or the bottom of the steam cylinder in exactly the same manner as in the present 9½-inch or 11-inch pumps.

The operation of the air end, however, is quite difficult. On the down stroke air is drawn in through the upper air inlet on the left-hand side of the air cylinder; it passes through the passage *m*, receiving valve 86, m_1, to the low-pressure volume above piston 66. When the piston reaches the lower limit of its stroke and starts upward, this air is compressed until the upper discharge valve 86_3 (on the upper right-hand side of the cylinder) is raised, then the air is forced through port r_1, discharge valve 86_1, passage g_1, receiving valve 86_2 and port m_2 to the annular cavity between the drum portion of piston 66 and the cylinder 63. Since this volume is much smaller than the low-pressure volume, the air is being compressed during its passage from the low-pressure to the high-pressure volume until, when the pis-

ton reaches the upper limit of its stroke, the air in the low-pressure clearance passages and high-pressure volume has reached the intermediate pressure of approximately 40 pounds.

During the following down stroke this high-pressure air is compressed until it raises the final discharge valve 86_3, when it passes through port r_2 and the discharge valve to the discharge orifice in the centre piece between the air cylinders.

This same operation occurs in the lower cylinder when the piston moves in the opposite direction from that described above, and as corresponding passages are designated by the same letter the operation can be readily followed through from the description just given.

The air cylinder is lubricated by three oil cups, as shown on Figure 2. The upper end receives its oil from the automatic oil cup placed just to the left on the upper centre piece. The piston drum receives its lubrication by the oil from the cup connecting with passage g_1 in the upper air cylinder, and is drawn into the high-pressure volume by the air as it goes from the low-pressure to the high. The lower end of the air piston is lubricated by the oil cup situated on the left side of the lower centre piece. The last two oil cups mentioned are old style air-cylinder oil cups, whereas the other, and that in the front view of the pump, are the new automatic air-cylinder oil cups. This cup can readily be used for the upper low-pressure cylinder whenever desired. It is thus seen that the complication due to compounding by this design is materially reduced, and all parts are made strong and durable and as nearly like standard simple pumps as it is possible to make them.

The Simplon Tunnel.

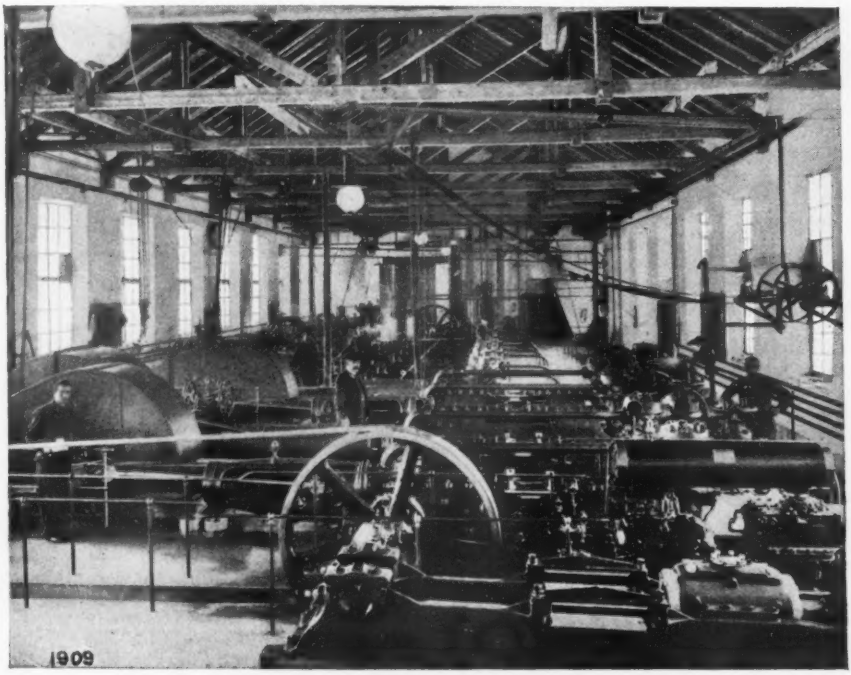
The Simplon tunnel, intended ultimately to pierce the Alps between Switzerland and Italy, is interesting as the longest of the great Alpine tunnels. When completed, it will have a total length of about 12¼ miles, as against 9¼ miles for the St. Gotthard and 8 miles for the Mount Cenis. It is distinguished from the other tunnels in the Alps by the fact that there are really two parallel tunnels, separated by about 55 feet between centres. Eventually each tunnel will contain one track. The bore is straight, with a knee at either end, due at the north end to the proximity of the Rhone River at the town of Brigue and at the southern extremity to the nearness of the Divernia, just below the town of Iselle.

The track at the north portal is about 2,250 feet above sea-level. From this point the tunnel rises with a 2 per cent. grade until the apex is reached almost exactly beneath the boundary between Swiss and Italian territory. This highest point is about 2,325 feet above the sea, and the bore falls thence with a 7 per cent. grade to the southern entrance, at an altitude of about 2,100 feet. The mountain over the tunnel is 7,000 feet in height and the thickness of rock above the tunnel at the apex is greater than anything ever before attained.

The method of building provided for the completion of the easterly tunnel as it is driven, while simultaneously only the floor heading of the second or western tunnel was carried along. The two bores are joined at intervals of about 650 feet by cross-galleries or traverses. While the two tunnels will ultimately be of the same size, it is the plan to finish but one at the present time, and enlarge the second at about the middle for a distance sufficient to permit trains to pass. When traffic increases so as to demand it, the second bore will be fully completed. An especial advantage of the double tunnel scheme developed in course of construction, in permitting a very effective system of ventilation. A very high temperature was encountered as the work progressed and in order to make conditions more tolerable, fresh air was forced in by powerful fans at the rate of about 1,250 cubic feet per second, entering heading No. 2, passing through the last traverse and returning outward through heading No. 1. Cross-galleries or traverses were closed as the work progressed, only the advance opening being kept clear. Even with such a circulation as this, it was found necessary to still further reduce the temperature at the face by sprays of cold water and for this purpose a great system of refrigeration was installed. The temperature of the rock in the tunnel was 55 per cent. Cent., but the cooling devices maintained the air temperature at from 25 per cent. to 30 per cent. Cent.

The construction of the tunnel was carried on simultaneously from both ends. The heading starting on the Swiss side at Brigue was pushed beyond the apex to a

point on the Italian side about 6½ miles from the Swiss portal. At this time the Italian heading had been advanced to within about 800 feet of the other heading and there remained this thickness of rock to be penetrated before the mountain was pierced. At this point, in September, 1904, unexpected obstacles to further progress were encountered, necessitating the abandonment of work on the Swiss side operations at that side. The work was completed by driving through the Italian heading, but here again operations were seriously impeded and the rate of progress cut down to a mere fraction of that normally maintained. When measurements showed that only a thin wall, which could be removed with one blast, intervened between the two headings, work was suspended until the greater part of the ac-



INTERIOR OF POWER HOUSE SHOWING AIR COMPRESSORS.

and seriously impeding operations in the Italian heading. These were springs of hot water at 45 per cent. Cent., opened almost simultaneously in the two headings; those on the Swiss side flowing about 489 gallons per minute, those on the Italian side 960 gallons per minute. The volume and temperature of this water in the Swiss heading, together with the destruction of the cooling plant for that section by a landslide, forced complete suspension of cumulated water on the Swiss side could be pumped out. Then the blast was fired, making an opening through which the remaining water rushed out to the Italian portal. This occurred on Feburary 24, 1905; and this date marks the culmination of the greatest tunneling enterprise ever attempted. The work was started in August, 1898.

Power for the Simplon work has been furnished by two plants of about 2,000

horse-power each, driven by water-power, one at either end of the tunnel. The method of tunneling was radically different from that familiar to American engineers and so often exemplified in tunnel work in this country. Instead of the compressed air rock drills so common in American practice, the Brandt system of hydraulic rock drills was used. Instead of chipping away the rock by hammer blows, it was ground away by cutters under tremendous pressure. Instead of the familiar air compressor plant, there were immense high-pressure pumps driven from water wheels. The ventilating fans also are driven by water-power. The tunnel section was enlarged by hand drilling.

But compressed air had its part in the enterprise, in operating the haulage locomotives handling construction trains in the tunnels. The illustration shows the interior of the power house at Brigue, Switzerland. In the foregound are seen the two Ingersoll-Sergeant air compressors furnishing air for these motors. One machine is seen complete, as it has been during its successful operation of several years. Its faithful performance led to the installation of its duplicate when the demands grew beyond its capacity. This second compressor is seen in course of erection. Both of these machines are belt-driven from water wheels and are of the style known by the makers as "Class BC 3." They are of the three-stage "straight-line" type, with water-jackets on the low pressure cylinder, horizontal intercooler, and water-box submergence on the high and intermediate pressure cylinders. They deliver air at 1,500 pounds pressure and at normal rating of 140 revolutions per minute, each compressor has a free air capacity of 121 cubic feet per minute furnished at this pressure.

The continuation of this great work under the unexpected difficulties encountered called for the exercise of resource and daring on the part of the engineers in charge. The driving forward of the Italian heading in the steaming, stifling heat from the hot water was in itself a wearing and laborious operation without precedent. Much curiosity and apprehension was felt as to the outcome of the piercing of the dividing wall. But this was made without mishap and since that time efforts have been directed toward enlarging, lining, and completion of the tunnel.

While one of the largest and most difficult tunnels, the Simplon was by no means the most expensive. Its cost thus far exclusive of installation charges, have been about $210 per lineal foot. In driving it ten thousand men have been continuously employed—four thousand on the Swiss side, six thousand on the Italian section. Its length, as stated, is 12¼ miles. The section of the completed tunnel is of horse-shoe shape, 13½ feet wide at bottom, 16½ feet at spring line and 18 feet high in the clear above the rails. It is lined with concrete and masonry throughout, the enormous pressure in some places calling for a lining 6 foot in thickness. The heading carried forward in the second and uncompleted bore, is 6½ feet high and 10 feet wide. Just what power will be used to haul trains through the Simplon tunnel has not yet been made public. But a recent order by the Swiss government for 160 cars with enclosed platforms seems to indicate that, for the present, at least, steam will be used.

Applications of Compressed Air in Railroad Work.

Now that compressed air has come into such general use in machine shops and other industrial establishments, it is particularly appropriate that something be said about the applications which are made of it by the leading railroads of the country. As everybody knows, the American railroad was the pioneer in the extensive use of compressed air. Compressed air was first applied to operate air brakes and later, when its usefulness became apparent, it was employed for hoists and pneumatic tools in repair shops. For this service small direct acting compressors, of the kind that are used on locomotives, were installed; but now, realizing the saving which may be effected by the use of two-stage machines, most railroads are equipped with thoroughly modern compressor plants and the most approved systems of piping.

One of the accompanying illustrations shows the interior of the compressor plant in the yards of the Delaware, Lackawanna & Western Railroad, at Hoboken. The compressors are of Rand, Class B-2 design, with 12 by 16 duplex steam cylinders and 18 by 11 by 16 two-stage air cylinders, having a displacement capacity of 565 cubic feet of free air when operating at 120 revolutions per minute. There are

only two of these machines, but they furnish all the air that is required and seldom need to run faster than 40 to 50 revolutions per minute. Probably, however, they would have to operate at their full capacity were it not for the admirable system of piping. This system provides for the distribution of air from a main battery of receivers near the compressor house to auxiliary receivers located just outside the different shops, thereby overcoming any great fluctuations in pressure when several pneumatic appliances are operating simultaneously.

weather, and if the air were not freed of a good deal of its moisture trouble would arise in winter due to freezing. The air for use in the shops does not pass through the aftercooler, but goes directly into the two receivers connected in series and is then distributed to the different buildings.

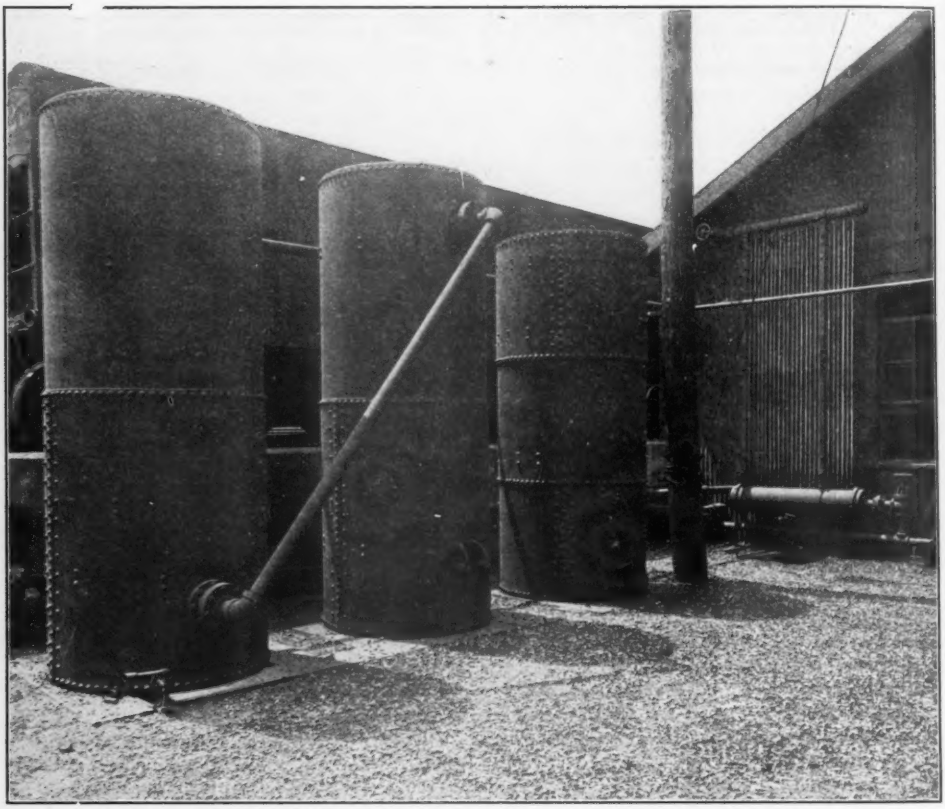
It is not only in the shops, however, that compressed air is used extensively; it is employed for operating signals, for cleaning cars, and for a great many other purposes, some of which we will take up in detail. Perhaps one of the most interesting of these is its application in the

CLEANING BY COMPRESSED AIR.

In No. 2 it will be seen that the main battery consists of three receivers, two of which are connected together. The third is used for supplying air to operate switches exclusively, and is connected with an aftercooler, shown in the background, and consisting simply of a nest of pipes exposed to the atmosphere. It is very important to cool compressed air before using it for the above purpose, as the pipes are exposed to all kinds of

roundhouse, as most people are not aware of the many ways in which compressed air may be used to advantage in places of this kind. The system of piping is the first thing to be considered in such a building and there are two systems in use, depending upon the design of the structure. If the roundhouse be constructed with a truss roof, having no centre supports, it is necessary to run the air pipes around the walls at a sufficient height to clear

doors and windows. Between each pair of tracks there should be a drop pipe, having a globe valve and elbow at the bottom to connect with a hose, which can be led to the different locomotives. This system of piping, however, has some very undesirable features, as it obstructs the passageway around the building. A better method, providing the roof is supported by struts, is to lead the main air pipe overhead around the central part of the building and have drop pipes attached to the supports between each pair of tracks. This method will insure a clear passageway to the rear of the locomotives and will also bring the compressed air taps nearer to where the pneumatic tools will be operated. Once the piping is installed compressed air may be put to innumerable uses, as it is possible to accomplish a great many minor repairs which otherwise would have to be made in the repair shop.



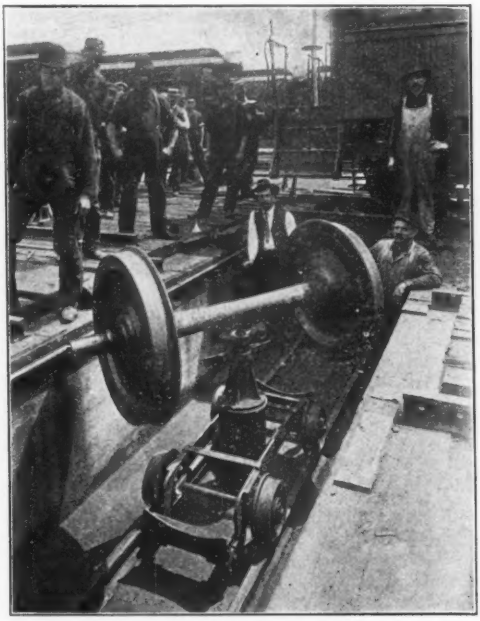
AIR RECEIVERS.

Certain tracks should have air jacks in the pits in order that locomotives may be lifted from their trucks that new wheels may be substituted for old ones, as shown in No. 3. The engine is first lifted from its truck by the air jack and blocked up with timbers; the jack then lowers the old set of wheels, which are received by a small truck and rolled from

under the locomotive to another part of the pit, where they are lifted to the surface by another jack. The whole process is of remarkably short duration and is certainly a great improvement over the old way of sending engines and cars to the repair shops. Other repairs consist of cutting off of stay bolts by pneumatic tools and expanding new flues into boiler shells. There is also a good deal of work where a piston drill is serviceable.

Compressed air may be used for blowing the fires in forges (of which there are generally several) and for starting fires in locomotives. This latter use is the means of a great saving, as most railroads have their own gas plants and may use the tar residue from the retorts for this purpose. The residue may be burned in the regular oil burner and will start the fires very much more quickly than wood, and without so much smoke.

It is usually important to keep the boiler flues in locomotives free from coal dust and cinders, and nothing is better for this purpose than a compressed air jet. This may be inserted in each flue in turn and will blow out all loose matter immediately. For this purpose stationary boiler plants in railroad yards should also use air jets, even if they are equipped with water tube boilers, as it is just as important to remove the loose matter from the outside of boiler tubes as from the inside of flues, and most water tube boilers are fitted with apertures in the front header between every four tubes, for the use of such a jet.



LIFTING CAR WHEELS.

The Delaware, Lackawanna & Western Railroad shops, just described, are thoroughly up to date, the purpose being to reduce repair costs to a minimum. Compressed air has been employed in these shops for a number of years and has aided materially in effecting a considerable saving in power and time. This means money and must therefore appeal strongly to all those interested in cost reduction.

W. R. Hulbert, M. E.

A Puncher Machine Mine.*

SOME OF THE DIFFICULTIES OF MANAGEMENT AND THEIR CAUSES—SUGGESTIONS FOR OBTAINING THE GREATEST EFFICIENCY OF PLANT.

A few years ago the position of mine foreman was a sinecure in comparison with his strenuous one of to-day. Individually, if those who have had charge of pick mines were requested to express themselves, we feel assured they would unanimously declare it easier to manage three ordinary pick mines than one machine operation. Many of the old-time foremen, who were successful managers under the old regime of the hand pick, should they be permitted to return from over the Styx, to acquaint themselves with the modern importation of trouble and vexation into the mines, would doubtlessly apply for a rib. Failing of that, their desire to again cross the great divide would be more ardent than to remain and be plagued to a speedy finish as a present day mine foreman or superintendent.

The old systems, methods, ways and means gave them small concern. Practically no machinery even for haulage; only pick mining, hand pumps, water box and mules.

Not even engineers to detect mistakes or interfere with the rule of thumb constantly applied. When men had no coal to load, they themselves were to blame; the face was theirs. Not so now; where their most laborious efforts were expended is now forbidden ground. Where their picks roamed from rib to rib anywhere from two to five feet under, is now the field of operation for the "iron man," whom they laughed to scorn and bespoke his signal failure only a few short years ago. This same metallic individual is praised and maligned every day of his existence, and will be as long as there is coal to be mined. When the miner sees an abundance of coal awaiting his shovel there is heard the words of praise; but let a "cleaned up," "not cut" place greet him, immediately his heart changes and anathemas profound and genuine are heaped upon the usurper of his room face, its runner and the day of their inception.

The subdivision of labor is inevitably accompanied by complications adding difficulties to its management. This is nowhere more manifest than in the mining of coal. Formerly the sole exponent of all the duties of present-day compressors, dynamos with their engines, engineers, boilers, firemen, pipemen, wiremen, machine boss, electrician, was the miner. Ninety per cent. of the machinery at mines where such has been installed is for the purpose of doing to-day what the miner and his pick did a few years ago, dig coal. This privilege he has, generally speaking, lost; but at a considerable cost, temporarily, to the operator, and with much trouble and vexation to the mine foreman and superintendent. The difficulties encountered in the management of a machine mine are not all embodied in the machinery and its application. Much of it is evolved from another source but which the machines are directly responsible for. One thing not always appreciated by operators and general managers is the degeneracy of the modern mine crew, compared to the day of the hand pick, when nearly all our miners were intelligent, industrious Americans, English, Scotch, Irish, Welsh and Germans. Their skill was the result of life-long training, acquired gradually under those who had attained perfection in the art of manual mining.

During the period of machine experimentation they were largely compelled to seize any reasonable opportunity to cease to be miners and become votaries of less fickle branches of industry. A few months spent in the largest steel works in America dispelled the doubt, as regards the Pittsburg District at least.

It was found that the skillful roller, heater, cinder man, dinkey driver, tapper, etc., was the quondam pick miner. His sons naturally are following him in his adopted vocations, thus losing to the mining industry this *genus homo* for all time. How utterly disgusting it must have been to receive orders to "square up the face, take down your slate, henceforth this will be a machine room," thus surrendering what had been his prerogative for generations and see it arrogantly taken possession of by that, which for years, he had ridiculed. It came, performed a few acrobatic stunts and everything else, but it cut coal. Then, for a change it would rupture some part, immediately the hue of the atmosphere was changed by the un-

*Written for *Mines and Minerals*, by Charlton Dixon.

printable expressions from the coal-expectant miner. Heartsick of disappointment he walked out, the machines remained, and in each case their status and utility were improved.

It does not require an expert to mark the difference when he of whom we speak and the majority of our present incumbents are in action. Neither grace, skill, nor judgment are manifest in the latter's flounderings. The experienced miner gazing at him when engaged is almost persuaded nature has bestowed upon him petrified vertebrae, and a frozen anatomy generally. Years of practice are essential to the acquirement of the easy sinous effective way of doing things which characterizes the experienced mine man. Pick miners are so rare to-day that many machine mines are unable to muster sufficient to draw the ribs back. The mine foreman in innumerable cases is compelled to utilize the Slav or other foreigner in an almost verdant state in order to keep his mine in shape. 'Tis right here the assertion that anyone is able to dig coal is proven senseless indeed. . The scene of such a person's attempt to undermine even after weeks of conscientious work is frequently ludicrous in the extreme. The upper part descending too rapidly, the lower ascending at the same speed, produce for him a puzzling horizon, and this at the expense of a herculean effort. Yet, he counts one when the amount of coal per capita is computed. A few of the above "miners" have their nullifying effect on the output and the mine foreman's efficiency. Of course, there are hundreds of fair workmen in the mines to-day, but the individual described is still the source of supply and will be. As a considerable percentage of the foreigners come with no intention of remaining permanently; periodically they return in droves, the object of their coming (a few hundred dollars to purchase a home plot in their native countries) having been accomplished, those who step into the vacancies must of necessity be the unsophisticated late arrivals from the same lands. .Probably there is no other country in the world where coal mining is carried on that suffers as much from this source as the United States.

The lower the efficiency of the men under him the higher it should be in the manager of them. The more he has been favored with the talents of an organizer the better it will be for himself and his employer. Deprived of these qualifications his mine will necessarily deteriorate and unless placed in the hands of one in possession of them will inevitably fail.

A few years ago a company operating a very large "puncher" machine plant found the time was ripe, on account of the absence of the gifts just mentioned, to make a change, which they did. The new man, without searching closely, found many proofs of the company's long suffering with numerous and various ear marks of deficient management. Many mining machines were stopped, piles of broken picks, coils of punctured air hose, several damaged trucks, two or three defunct air pumps, all awaiting repairs.

A party of men were eagerly inquiring of the blacksmith when their machines, hose, etc., would be ready for service. A crowd was interrogating them in their turn, as to the probability of their places being cut for to-morrow's loading. The grand army which emerged before 9 o'clock the following morning bore irrefutable testimony to the chaos existing in the cutting department. In conversation with some of them a sad state of affairs was discovered. "Our cutter machine has been in the hospital for three days," "my cutter has been on a jamboree since pay day." Another's "had no picks." The runner in our section is eternally behind; he has number so-and-so machine; it never did work satisfactorily and never will. Our man has quit, something went wrong with his machine, it was returned to the shop three times not having been improved; so on, *ad infinitum*.

The cutter had also a few specious excuses, such as machines of certain numbers, but uncertain proclivities to deal with—no drift pin, board too badly worn, clog played out, no picks, no air pressure, too much water in the pipes, some too many loaders, others, not enough. One indignantly averred that the night man on his machine had removed the cap and packed the ports and steam chest with slack coal. In addition to all this the supply of cutters was very inadequate, there being room for twelve to fifteen more could they be procured.

The mines were well equipped, first-class machinery, a sufficiency of all sorts of necessities, a proof of the general manager's foresight and readiness to assist all in his power. Hauling facilities A1, roads

in good order, yet the coal came not. Each day's record was two to three hundred cars short of expectations. As the cutting or lack of it was by far the most potent factor producing this serious loss, it was first taken up, analyzed and what subsequently proved to be the proper remedy, applied. The mine foreman, machine boss, fire bosses, blacksmith, mechanic and superintendent held a consultation at which it was brought to light that it was no one's specific duty to repair machines or their belongings. The machine boss was compelled to visit each cutter at work in both mines every day if possible; therefore he had no time to bestow upon them. The blacksmith with one helper was expected to sharpen all the hand and machine picks, repair cars, shoe thirty-five mules and four horses, keep in order thirty mining machines besides much other miscellaneous work common to all mines. He was the veritable factotum of the plant, a splendid mine mechanic, but unfortunately with only one pair of hands. The mechanic, proper, kept his eye on the machinery in a general way and his hands nearly always in his pockets. The mine foreman and fire bosses steered clear of everything pertaining to the cutting. The former declared, if coal were cut, he should see that it got out to the tipple. The fire bosses were unable to see how they could assist much in keeping the men in coal. All expressed a willingness to try to accomplish all that was requested of them and all were unanimously of the opinion that it was high time something was done.

Information elicited from the machine boss concerning cutter's sections showed that some consisted of as many as eleven rooms and nine loaders. The average was about nine rooms and six loaders, due to scarcity of cutters. Now the most expert of them were only able to mine three rooms per day, 24 feet wide and 4½ feet deep. The whole matter was thrashed out very carefully and resulted in specifying what needed immediate attention, and from which quick results might be expected. The repairing of the machines was turned over to the mechanic, who was furnished with an assistant. A special shop was provided for this work, a connection was made to the air line, a machine rest was built and firmly fixed, into which was placed each machine undergoing repairs and allowed to pound away until all doubts as to its fitness were removed. The instructions given to these men were to be certain that each machine, pump and hose was as near perfection as they possibly could make it before sending it again into the mine. This they conscientiously did. The complaint relative to too much water in the pipes was not denied but substantiated by the machine boss. So serious had it become that each hose was attached to a keg which acted as a receiver and eliminator; but, being cumbersome, besides providing additional joints to reduce an already inadequate supply of air, they were not satisfactory. To overcome this trouble a large receiver was located several hundred feet from the compressors along an old entry driven out to the power house. A trough was built around the intervening pipe, small dams built in it at intervals of twenty feet, which kept the pipe constantly submerged with a stream of cold water. We were fortunate in having same returned by gravity to daylight again. The receiver stood perpendicularly, the inlet about the centre, the outlet on top. The compressor engineers saw to blowing it out four times in the twenty-four hours. In addition to this a smaller one was placed three-quarters of a mile nearer the face in the traveling road of the mine; machine and fire bosses attended to the drainage as they passed to and fro each day. This completely annihilated all cause of complaint as to the quality of the air. It was now perfectly dry.

To increase the quantity was the next desideratum. This was partially attained by the pipe men who were instructed to commence at the compressors, follow the main lines and their most insignificant ramifications thereof and stop all leakage as quickly as possible, but to do so absolutely, which they did. It was customary for the miner after firing to turn on the air from the line to blow out the smoke (a highly expensive method of ventilating). The penalty for further indulgence along this line was three days' suspension for the first offence; instant dismissal for the second. This the mine and machine bosses attended to and rigidly enforced. Miners were strictly prohibited from carrying air-valve keys. All large hand-wheel valves on the different section lines were equipped with chains and locks, as the cutters were cute enough to know the more air they could prevent going into other sections the better their supply was.

Whenever they had an opportunity they arranged the valves accordingly.

In spite of these improvements and precautions complaints continued to roll in from the night turn. "No air after 12 o'clock," was the cry. A few nocturnal visits were made to the power house. Invariably the steam pressure was about 70 instead of 110 pounds; the compressors moving slowly, fireman dozing, the engineer at some distance from the building star gazing. To follow Ursa Major in its orbit or stare the north pole star out of countenance apparently concerned him more than there being any coal to load and haul the next day.

Soon the constellations lost their attraction for him, his field of observation was contracted to two Bristol gauges, one for steam, the other for air. The maintaining of the thin red line on the mark left no leisure for sleep or astronomy. To their credit be it said thereafter no more lamentations concerning lack of air were heard. Their love for the telltale gauge was at first and still is a minus quantity.

The total amount of available places were divided by six, which number was deemed sufficient to constitute a full section. Each cutter was allowed four men, these were to work in pairs, each to have three rooms. No singling out was permitted. By this arrangement they always had coal to load. Every pound of coal had to be loaded out of one room before commencing on another. In intervals of loading they took down the slate and prepared the "cleaned up" one for the machine again. Whenever the loaders failed to do this in a workmanlike manner the cutter and his helper completed the job, handing in the time they were engaged to the machine boss and it was deducted from the loaders.

It was now found there were many rooms left in the cold, as many sections had been contracted from eight and ten places to six. Cutters and men were moved up until each place was a part of some specific section. The remainder divided by six demonstrated the amount of cutters necessary to complete the complement.

Many rooms had been temporarily abandoned on account of meeting clay veins, spars, horsebacks and water. The cutters knowing there was always an abundance of territory preferred to quit or threaten to do so rather than work through the difficulty. Not wishing to see an already depleted force of cutters further diminished, the mine foreman had not insisted. This way of doing was playing havoc with the regularity of mining, also with the ventilation. Breakthroughs could not be driven, ribs of rooms long finished could not be extracted, resulting in all the loss and trouble mentioned in a previous article by the writer. To straighten out such a tangle, one of the best and most honest of the cutters was given the heaviest machine, also two good helpers. All were guaranteed a fair day's wage and ordered to pound all such places out of their trouble. When again in good condition they were made a part of a section. These men had their own check numbers, the coal they loaded in shaping up such places was credited to them. The balance necessary to meet their stipulated compensation was paid by the company. This proved to be a very satisfactory means of dealing with this annoyance.

While selecting the necessary machine men some amusing and ofttimes irritating questions were propounded by the applicants such as, "If I make a start with you can I have number so-and-so machine?" No, you would have to double on No. 24. Well if that's the best you can do I won't start, as that machine is no good. They were bright enough to ask the old cutters who furnished them the numbers of those machines whose reputations were tarnished before coming to the office. Many turned away on this account. This trouble was easily mastered by removing the number plate from every machine. By so doing their identity was utterly obliterated. In a short time the repairsmen were unable to distinguish one from another. Others requested one machine for their exclusive use. Some again wished to cut and load but no exceptions were made. The system mapped out was strictly adhered to; it was full section cutting and double shifting of machines, thus obtaining the maximum benefit.

Realizing that the importation of runners from other operations is a very precarious source of supply and that mines depending thereon have never a sufficiency, much less a surplus, a system to provide a steady supply of "home mades" was established, which in a comparatively brief period furnished them in abundance, enabling the general manager to draw

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therefrom to supply the demands of the company's other mines.

What was done there can be applied as effectively at any other place, if a little tact and patience are exercised. It was simply the selection of the best manipulators among the American, English, German, Slavs and Italians, giving them the best machines and sections, renting to them the most favorably situated houses, furnishing a few bolts of paper, manure for their gardens, etc., with the understanding they accept the scrapers sent to them by the management and make cutters out of them in the shortest time possible.

To procure the embryo cutter a canvass was made of all the strong young men, married ones preferred; if single, those whose parents were permanently settled in the neighborhood were preferred. They were told that their chances for obtaining employment by learning to run a machine increased many fold; instancing cases where only one of a group of men applying for work had succeeded and he solely because he had acquired the art of running a machine, many were induced to become apprentices.

When a likely looking fellow came along, regardless of nationality, he was employed as a scraper and sent, if possible, to one of the teachers speaking his language. He was informed that should he evince a fair share of energy and aptitude in a reasonable time he would be retained, if not he would not be given work at anything else, but discharged, as he had been hired for that only. When a learner was able to cut two rooms in eight hours, a check was given to him. He was then given a section in which one or two rooms were worked out. Here his education was finished.

From the time this system became operative there has never been a scarcity of cutters at that plant, although about fifty are constantly required.

The writer imagines some one saying, "Well, what guarantee was given that the cutters would do any better than formerly? Did the management get them in such a position that he could boss and command them?" We answer yes, and in this way: When organizing and building the cutter force, knowing that they, like the Chinese, are a little peculiar, no rules with penalties attached were enforced but, in proportion as a demand for machines was generated, pressure was brought to bear. They were first made to feel that everything in reason had been done for them. Each had six places, four loaders, twelve picks, good machine, plenty of dry air, good board, clog and drift pin. In each section an extra machine to take the place of any one that might break down.

At the first indication of a surplus of cutters each was told that he must work steadily and must keep his men in coal or he would be fired. They agreed to inform the machine boss when they intended to be idle for a day in good time to provide some one to take their place. Failure to do this meant three idle days for him. If idle two days without notification, he was supposed to have quit and his section was passed on to some one more anxious to work. Immediately the third pick was dull they were strung on a ring and sent to the shop. All dirt and grease had to be blown from, and the machines thoroughly lubricated last thing each turn. All were compelled to work night or day as the weekly bulletin designated.

The machine boss made out the above and posted it every Saturday morning at the office. It named the night men, also the day cutters for the following week. It was very important this be done; previously nearly all would appear on a Monday morning, when much wrangling was indulged in before the machine boss finally separated the two turns for the week. Subsequently the demand for coal was such that every machine was put to work. To make the power go around three shifts of seven and one-half hours were instituted. The bulletin told each runner his time of starting and quitting. By so doing the call for coal was satisfied until an additional compressor was installed. The fire bosses were made policemen over the cutters. Every morning at 6.30 A. M. their report showing the condition of the cutting in every section of the mines was found in the manager's office signed by the fire bosses. These were read first thing every morning by the machine and mine bosses. Should a section be reported as being behind, no time was lost in bringing it up to the required standard by sending an extra cutter to cut whatever was necessary. They, of course, left their checks to be sent out with the loaders, thus avoiding contentions by "divying up."

The most potent factor in the acquirement of and the maintaining of the whip

which kept them to their work was the fact that several were waiting anxiously for the opportunity of becoming regular cutters. No foolishness was tolerated and they had to do one of three things, "cut coal, quit or be dismissed."

Finally a code of rules setting forth the duties of the machine boss was framed and placed in his hands with the admonition to use good judgment; also, with the assurance that the management would most heartily co-operate with and sustain him in the enforcement of the same.

We give them here as suggestions for a more elaborate digest:

"The machine boss' duties are to have general inside charge of machines and to see that they are used in the proper manner. That each vent for lubrication is clean, affording a clear passage for the oil to the parts. That no machine is working with any loose parts. To do any small fixing necessary in order to keep a machine running until another one can be procured. To see that the one needing repairs is sent out promptly to the shop and is in the best possible condition before it is again sent into the mine. To inspect each machine every alternate day and particular ones as often as is necessary. To see, as far as possible, that every one is careful of his machine generally, and particularly of his supplies and tools and that the dirt and grease is blown off each machine and every moving part oiled last thing on each turn. To see that the cutters mine the coal the extreme depth of the machine's capacity and that the cutting be kept at the proper level. To see that the dull picks are sent out and the sharp ones in as promptly as possible, keeping track of the different kits. When a cutter quits or is discharged he will see that the full complement is available for the new cutter, including picks, clog, drift pin, wrenches and lubricators; to report any shortage, setting a price on the same, to be deducted from the quitting or discharged man's time. To have the issuing of the machine supplies, using good judgment in the same and seeing that all possible service has been obtained from the old parts, tools, etc.

"He may, when he considers a scraper competent to handle a machine, request that a section be given him.

"To enable him to do these things he will have the authority to stop a machine temporarily for inspection or permanently for repairs whenever he deems it necessary. Should a cutter refuse to do as he is ordered, as regards treatment of machine, depth of mining, etc., he may remove the regulator from the machine; then the foreman and he will decide what is best to do under the circumstances.

"He is hereby authorized to take a man from any part of the mine who has been employed as an extra cutter in order to keep a machine going or have day cutters cut a room or two at night; in fact to employ any fair and reasonable means to keep the loaders in coal."

Some time has elapsed since these things were done. The mines referred to are still the best of their kind. The same methods are yet in vogue. Coal never came steadier from any mines, pick or machine than it came and still comes from these. The annual output increased from 300,000 to over 500,000 or over 300 pit cars per day. All short-reach machines were gradually discarded and longer ones, capable of mining five and one-half feet (the height of the coal), were installed which improved the quality of and the demand for the coal.

Compressed air is a grand power for the mines, safe and sanitary. To give results it must be properly installed. The pity of it is it is so susceptible to abuse along this line. Many installations of boiler and compressors have been nearly white elephants on their owners' hands simply because no judgment was used in the piping. Too small from end to end. A penny saved in purchasing too small a pipe means dollars of loss besides mountains of trouble and dissatisfaction in the long run. In laying down a pipe of generous area in the first place, much benefit is derived from it, as less power is consumed than would be in a smaller, owing to less friction to overcome, but the full advantage is only apparent when it becomes necessary to increase the amount of compressor working on the line, which can be done cheaply, comparatively speaking, when the mains need not be changed. My advice to all contemplating the use of compressed air is to always provide an abundance of power and be liberal with your capital when the pipe end is being considered. It is discouraging besides being extremely laborious to a cutter to hold and guide a compressed-air machine working under inadequate pressure.

Notes.

The St. Louis office of the Sullivan Machinery Company, Mr. P. F. Jarvis, manager, has moved into larger quarters, the Missouri Trust Building.

A leather pneumatic automobile tire has been invented and its manufacturers claim that it is water, sand and puncture proof. A company will be formed in Detroit to handle the new tire.

It does not ordinarily pay to overload an air compressor with more drills than it is designed to carry, and it never pays to use a main pipe so small as to reduce the air pressure materially.—*Ex.*

Compressed-air locomotives are kept from operating, at times, in cold weather by the "air freezing," as is said. It is not the air, however, but the entrained moisture, that freezes.—*Engineering and Mining Journal.*

Much valuable information, regarding the mining industry in the State of Kentucky, is contained in the Annual Reports of the State Inspector of Mines, Mr. C. J. Norwood, for the years 1903 and 1904. These reports have just been published in book form.

Compressed air at 100 pounds gauge pressure requires approximately 1/5 horsepower per cubic foot of air compressed. In a note published in the October number of this magazine and credited to an exchange the horse-power required was incorrectly given as 1½.

H. M. Baxter, who was connected for three years with the Westinghouse Electric and Manufacturing Company in the purchasing and advertising departments, has established an office at Nos. 522-23-24 Park Building, Pittsburg, Pa., to handle the advertising appropriations of firms in the machinery and mechanical products business.

Compressed air is used in refining gold bullion. By blowing the air through the molten mass the base metals are oxidized and may be slagged off by a mixture of borax and sand. Lead and antimony are removed at an early stage, while copper is removed last and the silver remains with the gold. The losses of precious metals are small.—*Ex.*

The following bit of history is published in several newspapers:

"The compressed air rock drill is the invention of S. Ingersoll, who in 1871 applied for patents. The Ingersoll-Sergeant Drill Company grew out of this invention, and compressed air drills are now at work in all lands where mining is an industry."

Wind and water are so frequently mentioned in connection with mining stocks that it is interesting to find one instance where the use of these two great forces in nature are an actual asset. A gold mining company in British Columbia uses compressed air for hoisting and drilling, and the compression is secured by means of a water wheel. The wheel develops 90 horse-power under a head of 170 feet.—*Popular Mechanics.*

"Westinghouse Storage Batteries for Railway Signal Service," is the title of a small folder issued by the Westinghouse Machine Company, Pittsburg, Pa. While the publication is only a small one and devoted chiefly to illustrations, it is practically the first on this subject issued by the Westinghouse Machine Co., and serves as an announcement of this new and important branch of that company's business.

The use of the pneumatic hammer drill for mine sampling has been suggested, and it would, in many instances, no doubt, prove an excellent method of obtaining samples, particularly where it was desired to cut a channel across a face of hard quartz. Work with hammer and moil on this kind of vein material is slow and wearisome at least, and here the pneumatic hammer would find a useful field for its operation.—*Ex.*

Mr. C. S. Powell, general agent of the Westinghouse Electric & Mfg. Company, who has for some time occupied offices at 11 Pine street, New York, has removed to the offices of the Company, on the nineteenth floor of the Trinity Building, 111 Broadway. The Westinghouse Electric & Mfg. Company, in addition to its offices in the Hanover Building at 11 Pine street, occupies the entire nineteenth floor of the Trinity Building.

A. E. Hoermann, mechanical engineer, who has been with Curtis & Co. Mfg. Co., of St. Louis, for several years as chief engineer, intends to leave this firm December 1 to open an office at No. 261 Broadway, New York City, as manufacturers' agent and will make "Pneumatic Machinery" his specialty.

He will represent Curtis & Co. Mfg. Co. as well as the Dayton Pneumatic Tool Co., Dayton, Ohio, manufacturers of the "Green" hammer, and F. F. Slocomb & Co., Wilmington, Del., manufacturers of the Caskey hydro-pneumatic punch and riveter.

A good deal is being heard of the pneumatic tire which is to replace the ordinary rubber tire with a great saving of rubber. It is said the idea is an old one, though it does not seem to have had much of a trial. Whether it is a novelty or not, a strong London syndicate is now engaged in developing it, and great results are expected. The claim is that by the fitting of a pneumatic cushion round the hub the same effect, as far as easy running is concerned, is obtained as in the case of the ordinary rubber tire encircling the rim.—*Ex.*

The Central Railroad Company is conducting experiments at its shops in West Albany with a new method of firing locomotives. The coal is ground into powder and is then, by means of compressed air blown into the fire box and is consumed so completely that there is practically no smoke or refuse. The apparatus has been successfully used for stationary engines, but its vitality for traction engines remains to be demonstrated. Its economy is apparent, as it would save much fuel now wasted and would make the position of a fireman something of a sinecure.—*Ex.*

The printing of Alfred Domett's "Christmas Hymn" in illuminated text with four illustrations by F. X. Leyendecker in full color, beside eight other pages in tint, makes the Christmas *Century* a magazine rich in color. Among the pictures in tint will be Timothy Cole's wood-engraving of Zurbaran's "Saint Catharine in Prayer," a picture of the Christ by Paul Julien Meylan, and André Castaigne's drawing of an interior of the Hôtel de Crillon-Polignac. There will be also four full-page productions, in black and white, of drawings by Thornton Oakley of interesting scenes in lower New York.

Owing to the rapidly increasing southern business of the past year the De La Vergne Machine Company, of New York, has established a branch agency at Atlanta, Ga. This agency is to cover the states of North Carolina, South Carolina, Alabama, Florida and Georgia.

This agency will handle business connected with the three lines of machinery manufactured by the De La Vergne Machine Company, refrigerating and ice making machinery, "Hornsby-Akroyd" oil engines and Koerting gas engines. Mr. W. M. Hargreaves will be in charge, and the office will be located at 510 Candler Building.

The Colorado School of Mines is expanding and has received recently funds amounting to $75,000—the gift of Simon Guggenheim—which will guarantee the school a well-built and fully equipped Hall of Administration. The cornerstone was laid on September 30, 1905. The building will be constructed of golden gray pressed brick, with Fort Collins stone as a foundation. The commercial possibilities of Colorado and neighboring fields are well shown by the business done by only one large concern, namely, the Colorado Fuel and Iron Company, and the preparation of local men to step into technical and other positions in such enterprises is receiving attention.

The following note in substance is appearing in a number of newspapers and trade publications:

"A marked advance has recently been made in this branch of manufacturing in Germany, and a systematic effort is being made to overcome American com-

petition by applying recently invented improvements, and, at the same time, reduce to a minimum the cost of production. A well-known firm at Frankfort, which claims that its products excel in quality, simplicity, durability and cheapness, whose compressors are used by Krupp and similar firms, is now considering the advisability of establishing a branch factory in the United States if satisfactory arrangements can be made."

At a meeting and banquet of the Technical Publicity Association, held at the Aldine Club, New York, Friday evening, November 3, the following officers were elected: President, C. B. Morse, Ingersoll-Rand Company; first vice-president, H. M. Cleaver, Niles-Bement-Pond Company; second vice-president, Frank H. Gale, General Electric Company; secretary, Rodman Gilder, Crocker-Wheeler Company; treasurer, H. M. Davis, Sprague Electric Company; members of Executive Committee: Graham Smith, Westinghouse Companies, and Chas. M. Manfred, Johns-Manville Company. H. M. Davis addressed the association on "The Advertising Appropriation." An informal discussion followed, in which the members exchanged views on the disposition of advertising appropriations, the relative amount that should be spent in magazine and circular advertising, the relation between the advertising appropriation and the volume of business, etc.

An International Exposition under royal patronage will be held in Milan, Italy, from May to November, 1906, to appropriately celebrate the completion of the Simplon tunnel. Professor J. H. Gore, of George Washington University, Washington, D. C., and L. S. Ware, of Paris, are commissioners for this exposition. In a circular letter they say: It will be the largest European exposition ever held outside of Paris. Practically all of the European countries will participate officially, as well as several of the Asiatic nations. In the transportation section, retrospective exhibits will show the historical development of the various methods of travel. The dominant feature will be motion. All products, as far as possible, must be shown in connection with the processes, thus filling the halls with live exhibits. Arrangements will be made for field tests and competitive trials in all classes where it is expedient.

The evolution of the automobile torpedo continues, though forty years have elapsed since it was first made a practical success. The late Robert Whitehead deserves more credit for the development of the invention than any one else; for he was not only a pioneer, but he contributed more useful details to its design than others who worked on the same problems as he did. Yet there was a chance for improving upon even Whitehead's latest work. The United States government has adopted a torpedo which is distinctly superior to his in speed and range. It will travel faster by about eight knots an hour, and run almost twice as far before stopping. Compressed air supplies the motive power, as it does to the Whitehead, but the air is utilized by a different type of engine from that hitherto employed. A turbine has been introduced into the aerial, or rocket, torpedo within the last year or two, but we believe it has never until now been applied to the propulsion of the marine missile.—New York *Tribune*.

In the terminal yard improvement of the New York Central and Hudson River Railroad, about 100 Rand rock drills have been used and are operated by compressed air delivered through a 6-inch branch on the east and another on the west side of the yard. These branches supply also the hoisting engines, pumps, and most other machinery except the steam shovels, locomotives and concrete machinery, and receive air at 100-pound pressure through a 10-inch main from one Rand and one Ingersoll compressor, each with a capacity of 5,000 feet per minute, which are installed in the contractors' power plant at the foot of East 41st street. There are five Ransome concrete mixers operated by compressed air, and one operated by a General Electric motor. The smith shop, machine shop and repair shop, now temporarily located in the east extension of the yard, are equipped with an 800-pound steam hammer, a drill press, ordinary hand and machine tools and drills, hammers and other tools operated by air pressure.

According to a Washington dispatch, the commission that has been investigating the use of pneumatic tubes will recommend the construction of a pneumatic tube from the post office to the Union depot in Kansas City. The tubes if installed are expected to reduce to fifteen minutes or more the time in handling the mails.

A few years ago, when Sam F. Scott was postmaster, a franchise was granted by the city for a pneumatic tube company, but nothing more ever came of it. Philadelphia, New York, Boston and Chicago now have pneumatic tube service and the commission is said to have agreed to recommend important extensions in these plants and the installation of tubes in St. Louis, Kansas City and probably some other cities. In St. Louis two tubes are to cross the Missouri river and mail to and from the East is to be loaded and unloaded in East St. Louis, so that mail from the East will be in the St. Louis post office several minutes before the train that brought it has reached the Union station.—*Kansas City Star.*

The *Engineering World* is featuring a series of articles from the pen of Mr. Halbert P. Gillette, M.A.S.C.E., M.A.I.M.E. He is an experienced and proved engineering writer and editor, whose practical work as an engineer and whose editorial work as associate editor of *Engineering News* combines in him qualities calculated to make his knowledge and opinions of timely service to all engineers. He has the faculty of treating subjects of everyday import which have been neglected hitherto by other writers. His method is pertinent, direct and exceptionally practical. Indeed, it will be readily remembered that it was the department in *Engineering News,* conducted by Mr. Gillette, that dealt so thoroughly with contracting cost and procedure as to excite unusual interest throughout the country and to result in thousands of inquiries from contractors and engineers who waited on him for instruction and advice. Thousands of specifications came to him for revision and extension. The merits of his work in this department have probably been felt to advantage in every section of the country. Mr. Gillette's book on "Rock Excavation" is one which is of special interest to users of rock drills.

The question of springs for automobiles is a perplexing one to the manufacturer, as the light, flexible springs which make such comfortable riding at slow speeds on ordinary roads, play so freely on bad roads and at high speeds that bumping on the axles results when the springs are compressed, and often in the rebound the springs break.

A new device intended to absorb the shock of spring play and make the flexible springs practical and comfortable on any road is in the shape of a cylinder in which works an airtight piston. The cylinder is attached to the axle and the piston to the car frame, by means of suitable brackets, while freedom of movement in all directions is secured by universal joints at the points of attachment. A cap or casing on the plunger fits closely over the cylinder and excludes the dust. The cylinder contains sufficient lubricant for 10,000 miles running and on ordinarily uneven roads the air cushion allows the springs to move freely with comfort to the passengers, while at too great speed over rough places the cushion absorbs the shock, sparing the injurious effect on the springs and gradually brings the car to a stop. Wear on machinery is thus greatly reduced, as well as the comfort of the occupants of the vehicle being promoted.—*Ex.*

At the ninth annual convention of the Central States Water Works Association, recently held at Columbus, O., a paper was read by Mr. John Langan, of Tipton, Ind., explaining his experience in lifting water from deep wells by the use of compressed air. Four years ago he read a paper on the same subject before the Association, which attracted much attention. Since then he has been making a number of experiments with different types of nozzles, and succeeded in this way in bringing up the yield of a 6-inch well 280 feet deep to about 40 gallons per minute. He was unable to increase this

discharge until he adopted a Harris apparatus. With a depth of 138 feet to the suction inlet, a ¾-inch air line and 45-pound working air pressure, he has since been able to maintain a steady discharge of 150 gallons per minute from this well. This device was explained at some length by the inventor, Mr. Walter B. Harris, of Indianapolis.

The next meeting will be held at Cincinnati. The officers elected for the ensuing year are: President, C. J. Thuman, Evansville, Ind.; Vice-President, A. W. Inman, Massillon, O.; John Langan, Tipton, Ind.; W. H. Glore, Covington, Ky.; T. H. Morton, Nashville, Tenn.; A. L. Holmes, Grand Rapids, Mich.; W. Schwertfeger, Wheeling, W. Va.; Secretary, Wm. Allen Veach, Newark, O.; Treasurer, Charles E. Rowe, Dayton, O.; Executive Committee, A. H. McAlpine, Columbus; T. R. Cook, Toledo, O.; C. W. Wiles, Delaware, O.

Compressed air and electricity are the two new powers and are new fields for industrial research. Electricity has advanced beyond compressed air in the industrial march, as it has always had this strong point in its favor—that an electric plant must be properly installed; that certain fixed laws of science must be respected in the installation of electric plants has been acknowledged by engineers for some time, as the defective installation of electric equipment means that when it is placed in operation a series of difficulties will follow; that you will have short circuits, grounds and burnouts of all kinds, and it may even be a menace to human life. With all of these difficulties confronting engineers, they have learned to respect the laws of science that apply to this particular power.

With air power it is different, for it is a safe power with which there have been too many unreliable experiments. A combination of human nature, business enterprise and greed is somewhat responsible for the conditions which result in many points being overlooked by the prospective purchaser or actual user and quite as often being disregarded by the manufacturer, either purposely or through ignorance.

First cost of installation, in too many cases, is made the paramount issue. First, a compressor of too small a size is ordered. To this is added defective installation. A receiver of unsuitable size and design is used. The air is taken to the compressor, in many cases, through a duct leading from some room filled with dust and grit, and to this is added a defective system of piping for transmitting the air to various places for different uses.

The pipes are too often carelessly laid down filled with sags and pockets and are of too small a size to transmit the air required for the work and considerable loss follows, due to retardation by friction of the pipes. An insufficient supply of cooling water is furnished by the water-jacket for intercooling purposes. And with all these faults it is a power so simple that it does not refuse to work although its efficiency may be cut down 50 per cent.

Compressed air will exert the force that remains in the same safe way, because, unlike electricity, it cannot resent the wrongs that have been thrust upon it.—*Mines and Minerals.*

FOR SALE.

At less than cost, the following imported Mannesmann tubes, designed for storage of compressed air:

12 tubes 20 ft. in length
78 tubes 15 ft. 4½ in. in length.

All designed for a working pressure of 2000 pounds per square inch and tested to 4800 pounds per square inch. All tubes are new and have never been in service.

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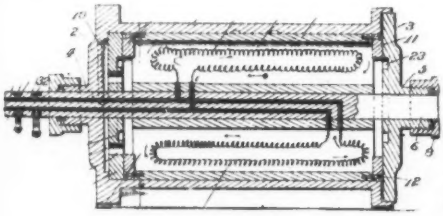
U.S. PATENTS GRANTED OCT., 1905.

Specially prepared for COMPRESSED AIR.

800,736. AIR-BRAKE MECHANISM. Alva L. Goodknight, Council Bluffs, Iowa, assignor of one-half to John P. Crick, Lead, S. D. Filed Feb. 1, 1905. Serial No. 243,725.

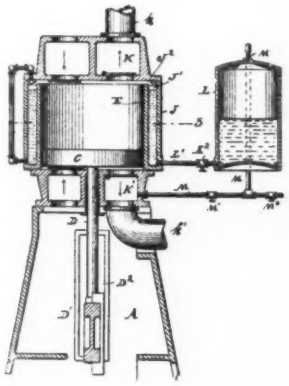
800,740. AUTOMATIC CUT-OFF. Ferdinand Hoelder and Charles J. Welzin, New York, N. Y. Filed Apr. 5, 1905. Serial No. 254,036.

800,765. PNEUMATIC COMPRESSOR. Lebbeus H. Rogers, New York, N. Y. Filed Dec. 29, 1904. Serial No. 238,821.



An air-compressor pump, a revoluble piston-carrying drum having oil-spaces within the same, a shaft for rotating said drum, electric heating means in said oil-spaces, leads in said shaft connected in parallel with said electric heating means, and slip-rings on said shaft connected to said leads.

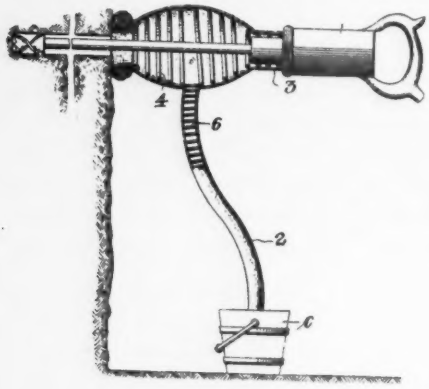
800,769. COMPRESSOR. Alfred Steinbart, Carlstadt, N. J. Filed Feb. 20, 1904. Serial No. 194,513.



A compressor-cylinder having its compression-cylinder connected with a chamber, a liquid-tank connected with the bottom part of said chamber, an air-pipe extending from a compressed-air outlet of said compression-cylinder to said liquid-tank and cocks in said connections between the chamber, the liquid-tank and the compressed-air outlet to force, by means of air compressed in the compressor-cylinder, a liquid from the tank into said chamber or from said chamber into the tank, substantially as set forth.

800,809. PNEUMATIC-TIRE GUARD. Thomas H. Lindley, Cedar Rapids, Iowa. Filed Jan. 3, 1905. Serial No. 239,514.

800,818. DUST-ARRESTER FOR PNEUMATIC DRILLS AND REAMERS. Lee M. Parrett, Butte, Mont. Filed June 19, 1905. Serial No. 266,009.



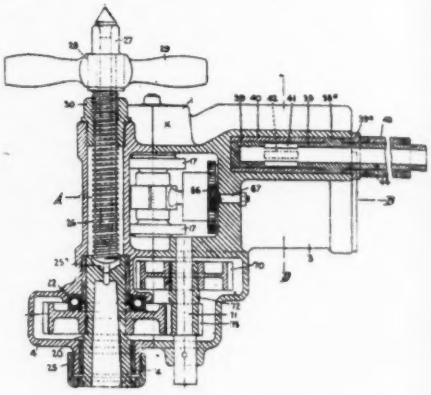
The herein-described dust-arrester for pneumatic drills and reamers, comprising a flexible, substantially tubular body portion having an opening at one end to receive the outer end of the drill, an opening at the opposite end to clear the drill-bit, an annular packing at the last-mentioned end, for the purpose set forth, a coiled spring in the said body, bearing against the ends thereof and serving to prevent the flexible body from collapsing and also serving to cushion the drill or reamer, and a discharge-tube leading from one side of the said tubular body.

800,884. PNEUMATIC-DESPATCH APPARATUS. Charles F. Stoddard, Boston, Mass., assignor to American Pneumatic Service Company, Dover, Del., a Corporation of Delaware. Filed May 13, 1904. Renewed Feb. 9, 1905. Serial No. 244,905.

800,967. PNEUMATIC MATTRESS, ETC. Albert A. Young, Wakefield, and Thomas A. Abbott, Reading, Mass., assignors of one-half to George S. Tolman, Winthrop, Mass., and C. L. Sopher, Wakefield, Mass. Filed Oct. 20, 1904. Serial No. 229,213.

800,981. AIR-BLAST ATTACHMENT FOR DENTAL ENGINES. James W. Buchanan, Savannah, Ga. Filed Oct. 29, 1904. Serial No. 230,553.

800,939. PORTABLE PNEUMATIC DRILL. Henry S. Potter, Bromley, England. Filed Jan. 9, 1905. Serial No. 240,345.



The combination, with a shaft or socket for operating the tool, feed mechanism for moving the said shaft or socket longitudinally, and a detachable casing supporting the said parts; of a main casing having the said detachable casing secured to it, two power-cylinders carried by the said main casing, two stuffing-boxes also carried by the said main casing, pistons slidable in the said cylinders and provided with trunks which are slidable in the said stuffing-boxes, two crank-shafts journaled in the said casings at their connecting joint, connecting-rods between the said crank-shafts and pistons, toothed driving-wheels operatively connecting the said crank-shafts with the said shaft or socket, and valve mechanism for admitting pressure fluid first to the front ends of the said cylinders and thence to their rear ends in which it operates expansively.

801,042. DRILL-CHUCK. Gaylord A. Orr, Cripplecreek, Colo. Filed Mar. 1, 1905. Serial No. 247,948.

A drill-chuck, in combination, a head having a bore extending upwardly therein adapted to receive a drill-shank and having a transverse opening, a link presenting an elongated eye and adapted to be passed completely through said opening, a block mounted in said opening and adapted to clamp the drill-shank, and a wedge resting against the outer face of said head and against the inner side of one extremity of said link.

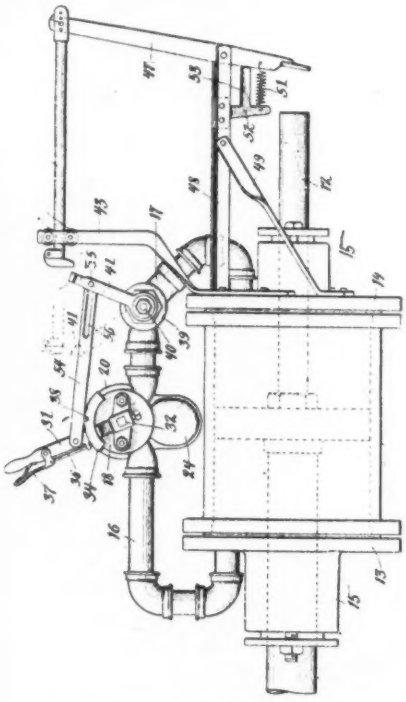
801,209. PNEUMATIC-TIRE VALVE. Littleton K. Buck, Freehold, N. J. Filed Dec. 12, 1904. Serial No. 236,473.

801,096. FLUID-PRESSURE ADJUSTING MECHANISM. Charles M. Manly, Washington, D. C. Filed Aug. 20, 1902. Serial No. 120,415.

The combination with a variable-speed gear consisting of a pump and a motor, of a secondary fluid-pressure motor and connections between said motor and variable-speed gear, whereby the speed-gear may be adjusted for different speeds, substantially as described.

801,150. PNEUMATIC TIRE. James A. Murphy and William S. Manning, Holyoke, Mass., assignors to Manning Manufacturing Company, Springfield, Mass., a Corporation. Filed Dec. 5, 1904. Serial No. 235,600.

801,332. FLUID-PRESSURE MOTOR. Francis H. Niles, Chicago, Ill., assignor to Featherstone Foundry and Machine Company, Chicago, Ill., a Corporation. Filed May 23, 1904. Serial No. 209,226.



In fluid-pressure motors for reciprocating hammers and the like, the combination with the cylinder, piston and piston-rod, of inlet and exhaust passages opening into opposite ends of said cylinder, valve mechanism controlling the flow of fluid through said passages, means for manually actuating said valve mechanism and means automatically controlled by the travel of the piston for actuating said valve mechanism to throttle or cut off the exhaust from the rear end of said cylinder to cushion the return or idle stroke of said piston, substantially as described.

801,359. PNEUMATIC TIRE. Henry W. C. B. Cave, London, England. Filed Oct. 1, 1904. Serial No. 226,876.

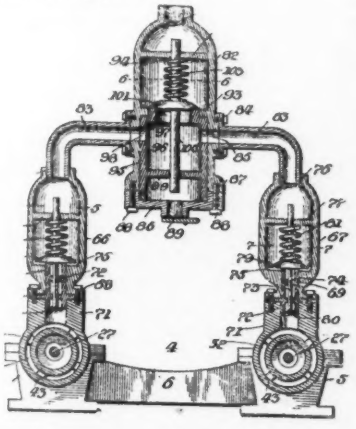
801,386. DRILL-CHUCK. Anthony F. Lagerstrom, Chicago, Ill. Filed Dec. 30, 1904. Serial No. 239,031.

A drill-chuck comprising a cylindrical casing, a turning-plate therein having crossed slots and projecting studs, a spring connected to the casing and having a hook at one end engageable with one of the studs on the plate, and jaws pivotally supported in the casing and having pins which project into the slots in the said plate.

801,571. PNEUMATIC CONTROLLING DEVICE FOR ORGANS. Henry L. Davis, New York, N. Y. Filed Oct. 21, 1904. Serial No. 229,399.

801,580. ATTACHING-COLLAR FOR PNEUMATIC TIRES. Jules C. N. Fouilloy, Paris, France. Filed Feb. 20, 1905. Serial No. 246,588.

801,599. AIR-COMPRESSOR. William R. Leroy, Washington, Pa. Filed Nov. 25, 1903. Serial No. 182,614.



An air-compressor a pair of water-jacketed parallel compressor-cylinders, pistons in said cylinders, means for operating said pistons alternately in their forward and backward strokes, ports in the pistons to permit air to pass there-

through during the stroke of the piston in one direction, valves closing said ports during the strokes of the piston in the opposite direction, an outlet-port in one end of the cylinder, auxiliary controlling-valve casings mounted on the cylinders intermediate their length, ports extending through the walls of the cylinders and establishing communication between said valve-casings and the cylinders, a main controlling-valve casing in communication with a reservoir, connections establishing communication between the main controlling-valve casing and the auxiliary controlling-valve casings, spring-pressed controlling-valves in the auxiliary controlling-valve casings, an annular casing arranged within the main controlling-valve casing and into which the air from the auxiliary-valve casings is discharged, and provided with a port in its upper end, and a spring-pressed valve normally closing said port, substantially as described.

801,646. APPARATUS FOR PREPARING INGOT-MOLDS FOR THE CASTING OPERATION. Hugo Carlsson, Stockholm, Sweden, assignor of one-half to James H. Le Fevre, Buffalo, N. Y. Filed June 4, 1904. Serial No. 211,092.

A steel plant, the combination of a track for conveying the ingot-mold-carrying cars, a spraying device above said track and adapted to spray the inside of the ingot-molds with a suitable substance, a reservoir of the said substance in connection with said spraying device, a source of compressed fluid, a pipe therefrom entering said receptacle, and a valve in said pipe for controlling the passage of the fluid therethrough.

801,776. AIR-BRAKE ATTACHMENT. William Drake, Bradford, Pa. Filed June 16, 1905. Serial No. 265,572.

802,051. COMPRESSED-AIR BRAKE FOR RAILWAY-WAGONS AND THE LIKE. Charles Luyers, Brussels, Belgium. Filed Sept. 28, 1903. Serial No. 174,931.

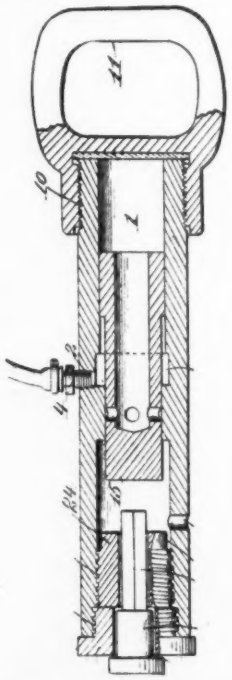
802,094. AUTOMATIC FLUID-PRESSURE BRAKE SYSTEM. John S. Bubb, Kittanning, Pa. Filed Mar. 9, 1903. Serial No. 147,042.

802,132. PRESSURE-REGULATOR. Edward V. Anderson, Pittsburg, Pa. Filed Jan. 21, 1904. Serial No. 189,990.

A pressure-regulator, a casing having a high-pressure inlet and a low-pressure outlet, an apertured partition separating the inlet and outlet, a valve regulating the passage of fluid through the partition, a piston-chamber and pston, said regulating-valve having a valve-stem provided with ports respectively in communication with the inlet and piston-chamber and a fluid-passage connecting the ports, a valve controlling the passage of high-pressure fluid through the passage in the valve-stem, and pressure-adjusting mechanism carried on the valve-stem, substantially as set forth.

802,286. FLUID-PRESSURE BRAKE. Maury W. Hibbard, Chicago, Ill. Filed Mar. 13, 1905. Serial No. 249,779.

802,303. PNEUMATIC HAMMER. Jeremiah Murphy, Leadville, Colo., assignor to Charles T. Carnahan, Leadville, Colo. Filed Apr. 8, 1905. Serial No. 254,557.



A pneumatic hammer, the combination with a cylinder having one end provided with two sets of threads, the threads of one set extending in an opposite direction with respect to the threads of the other set, of a drill-socket consisting of a bushing formed of an inner and an outer threaded section adapted to engage with the threads of the cylinder, the threads of one section extending in an opposite direction with respect to the threads of the other section, said inner section of less diameter than said outer section and said inner section having a reduced inner end out of engagement with the cylinder.

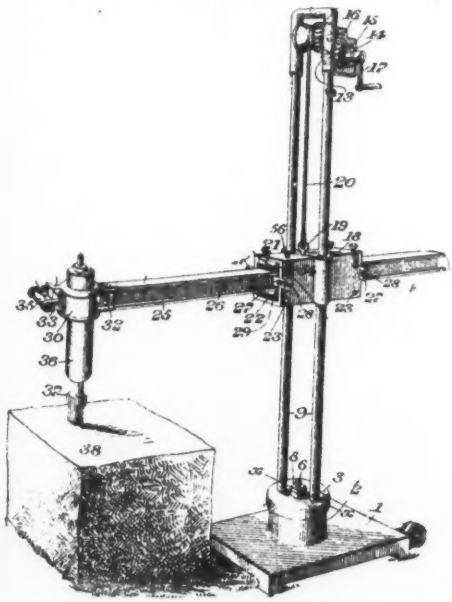
802,319. POWER-HAMMER. Oliver B. Reynolds, Brockton, Mass. Filed May 28, 1904. Serial No. 210,220.

A power-hammer, in combination, a ram, ram-actuating mechanism, a pitman-head, two pair of springs rigidly secured to said pitman-head, the springs of each pair being arranged convergently toward and secured together at their free ends, and links connecting said free ends with said ram, substantially as and for the purpose set forth.

802,449. CUSHION TOOL-HOLDER FOR PNEUMATIC HAMMERS. Stephen W. Goodhue, Indianapolis, Ind., assignor of one-half to Opal Sedgwick, Casey, Ill. Filed Oct. 3, 1904. Serial No. 227,028.

A tool-holder consisting of a main body carrying in its lower end a pair of jaws between which a tool may be inserted, a clamping-shell threaded on said jaws, and an abutment also threaded upon said jaws within said shell and arranged to engage the inner end of the tool mounted between the jaws.

802,457. PNEUMATIC-SURFACER FRAME. Herman G. Kotten, New York, N. Y. Filed May 3, 1905. Serial No. 258,736.

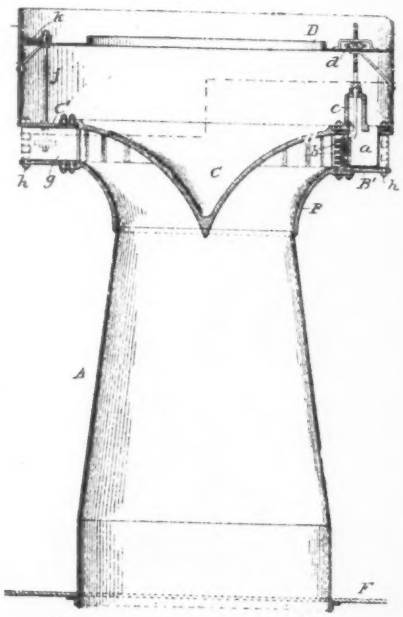


A pneumatic-surfacer frame, a base, a bearing thereon, comprising a hollow projection, a cap carried thereby, ball-bearings intermediate said cap and the upper portion of said projection and a depending sleeve within said bearing and integral with said cap, a clamping device common to said bearing and cap and uprights secured to said cap, a carrier vertically movable on said uprights, and an arm laterally movable carried by said carrier and to which a pneumatic tool is secured.

802,333. PNEUMATIC COUPLER FOR ORGANS. Joseph Slawik, Philadelphia, Pa. Filed July 18, 1900. Serial No. 24,058.

802,526. PNEUMATIC MATTRESS AND CUSHION. William M. Russell, Jr., Pink, Ala. Filed Jan. 28, 1905. Serial No. 243,109.

802,575. HYDRAULIC AIR-COMPRESSOR. William J. Linton, Woodstock, Canada. Filed June 4, 1903. Serial No. 160,002.



A hydraulic air-compressor, a head-piece forming the mouth through which water is admitted to the apparatus and a series of air-inlet chambers arranged within said mouth and dividing it into separate water-passages each of which chambers is connected with the air outside and is open to the water at its inner end, and means for regulating the size of said water-passages.

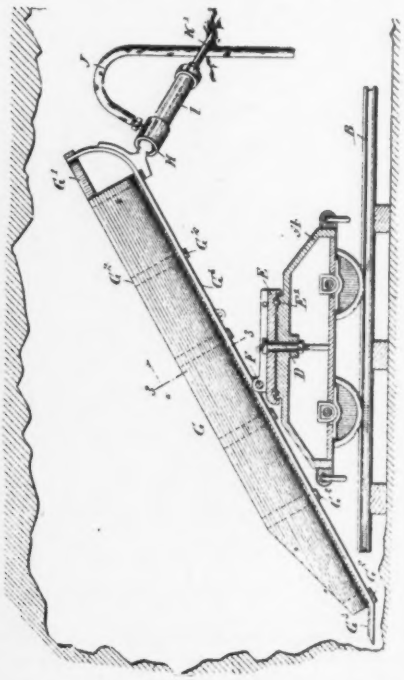
802,580. PRESSURE-REGULATOR. James D. Moffett, Lufkin, Tex. Filed Mar. 2, 1905. Serial No. 248,181.

A pressure-regulator, comprising a conduit for the pressure-producing medium, a governor-valve connected into said conduit, a cylinder having a plunger operating therein and connected to said conduit between said governor-valve and the outlet end of the conduit, a controlling-valve between said cylinder and conduit, and a piston-rod between said plunger and the operating-arm of said governor-valve.

802,600. TIRE. David R. Salisbury and Oliver D. Salisbury, Owosso, Mich. Filed Jan. 4, 1905. Serial No. 239,546.

802,735. PNEUMATIC-TIRE PROTECTOR. Pierre O. Casavant, Point St. Charles, Canada. Filed Oct. 26, 1904. Serial No. 230,007.

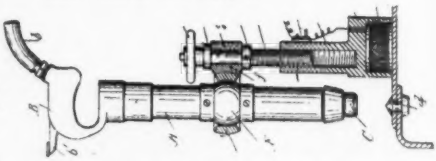
802,783. CAR. Theodore H. Proske, Denver, Colo. Filed Apr. 6, 1905. Serial No. 254,238.



A car for receiving material resulting from a blasting operation, comprising a truck, a platform mounted to turn on the truck, a body pivoted on the said platform, to allow of swinging the body into an inclined position, and cushioning means connected with the upper end of the said inclined body, to sustain the latter in an inclined position and to take up the shock incident to the blasting operation, said means embodying a device for anchoring the car in an inclined position.

802,801. VALVE FOR FLUID-MOTORS. Thaddeus C. Dunlap, Columbus, Ohio. Filed July 25, 1904. Serial No. 218,050.

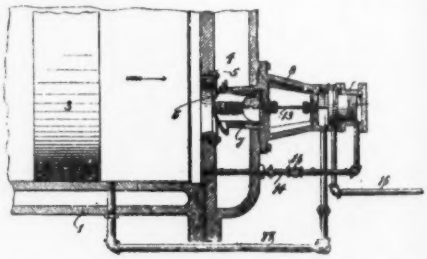
802,820. PERCUSSION-TOOL. Jesmond T. Nicholson, Wilkesbarre, Pa. Filed Sept. 27, 1904. Serial No. 226,150.



The combination, with a percussion-tool, of a ball-and-socket joint supporting the said tool, a feed-spindle journaled in a bearing at one side of the socket of the said joint and provided with means for revolving it by hand while the tool is at work and having also a screw-threaded portion, an electromagnet for holding the said tool to the work, and a shoe secured to the said electromagnet and provided with a screw-threaded portion for the said screw-threaded portion of the feed-spindle to engage with.

802,913. PNEUMATIC BRAKE FOR GOODS-TRAINS. François J. Chapsal and Alfred L. E. Saillot, Paris, France. Filed Dec. 28, 1904. Serial No. 238,648.

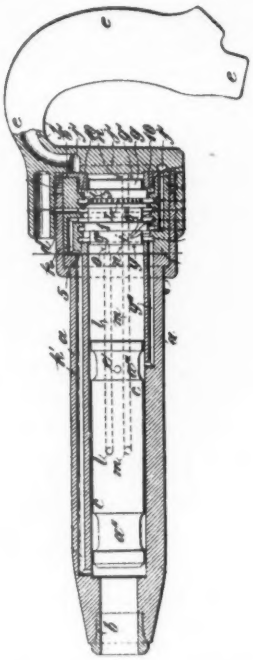
803,192. MEANS FOR OPERATING THE DISCHARGE-VALVES OF HIGH-PRESSURE CYLINDERS. William Prellwitz, Easton, Pa., assignor to The Ingersoll-Sergeant Drill Company, New York, N. Y., a Corporation of West Virginia. Filed Jan. 26, 1905. Serial No. 242,798.



A compression-cylinder, its piston, a discharge-valve, operating-pistons therefor of varying areas, means for applying a combination of high and

low pressure to one side of the valve-operating pistons and means for applying first high and then low pressure to the other side of the said pistons as the compression-cylinder piston moves toward the discharge-valve.

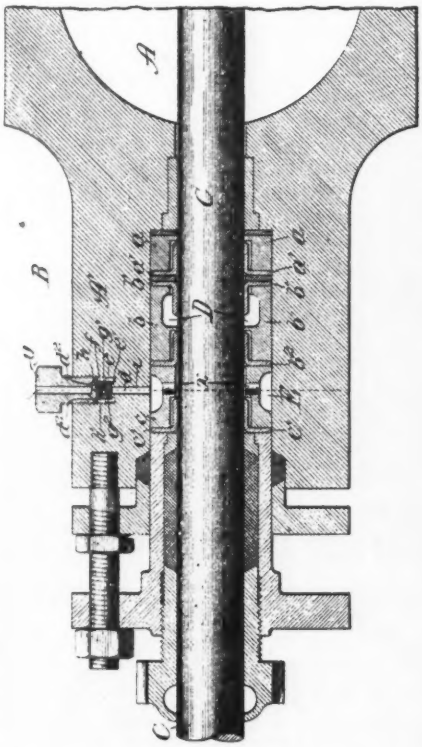
802,984. PNEUMATIC HAMMER. Mark H. Green, Manchester, England. Filed June 22, 1903. Serial No. 162,602.



A pneumatic hammer and like tool comprising a valve, provided with rings on its exterior surface of equal diameter, a series of grooves alternating therewith each of equal diameter but of less diameter than the rings and a series of holes communicating with one of said grooves and with the interior of the valve, of a valve-box provided on its interior surface with a series of rings, corresponding in diameter with the rings on the valve, a series of annular spaces alternating with said valve-box rings, live-air-supply passages in the valve-box communicating with the annular spaces of the valve-box, a series of passages in the valve-box communicating respectively with passages in the cylinder of the hammer and with the atmosphere, a cylinder provided with a slidable piston having annular grooves near each end, a series of passages in said cylinder communicating with the passages and grooves in the valve-box and with the annular grooves in the piston, as and for the purpose set forth.

803,053. TIRE. Henry G. Fiske, New York, N. Y., assignor, by mesne assignments, to Morton Trust Company, trustee, a Corporation of New York. Filed June 17, 1899. Serial No. 720,915.

803,260. GAS-COMPRESSOR. Frederick Wittenmeier, Chicago, Ill., assignor to Kroeschell Bros. Ice Machine Co., Chicago, Ill., a Corporation of Illinois. Filed Oct. 18, 1904. Serial No. 228,925.



In combination, a gas compressor stuffing-box having a plurality of packing rings equipped with cup-leathers about the piston-rod, a chamber formed in the outer surface of the outermost ring and a chamber formed in the inner surface of the next adjacent ring, said chambers opening to the piston-rod, a duct leading out of said outermost chamber from above the plane of the piston-rod to the suction side of the compressor, and a regulating-valve controlling the discharge

through said duct from said last-named chamber and adapted to be opened by pressure in the latter, substantially as described.

803,345. PNEUMATIC-TIRED WHEEL. Thomas B. Jeffery, Kenosha, Wis. Filed Nov. 21, 1904. Serial No. 233,697.

803,388. PNEUMATIC CARRIER. Thomas Bemis, Indianapolis, Ind. Filed Aug. 14, 1905. Serial No. 274,083.

803,467. AUTOMATIC EMERGENCY AIR-BRAKE-OPERATING DEVICE FOR RAILWAYS. John P. Birmingham, Lexington, Va., assignor to Robert Catlett and Robert Athelstan Marr, Lexington, Va., William George Mathews, Clifton Forge, Va., and James Easley Edmunds, Don Peters Halsey, and James William Gerow, Lynchburg, Va. Filed July 31, 1905. Serial No. 272,024.

803,482. COMPRESSED-AIR WHISTLE. Frederick Heckler, Fremont, Ohio. Filed Feb. 6, 1904. Serial No. 192,398.

803,510. PNEUMATIC TIRE. William A. Sankey, Sutton, England, assignor to Frank Reddaway, Pendleton, Manchester, England. Filed Jan. 24, 1905. Serial No. 242,545.

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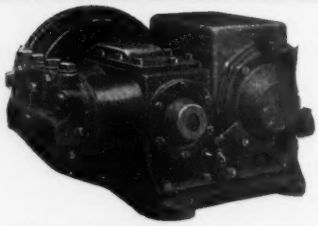

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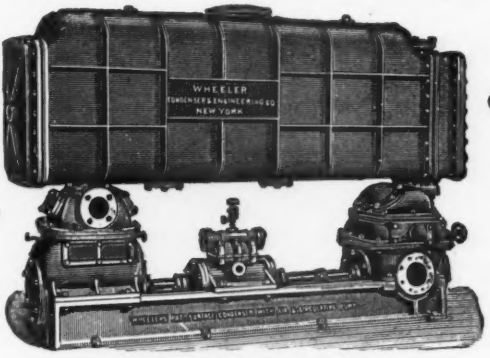

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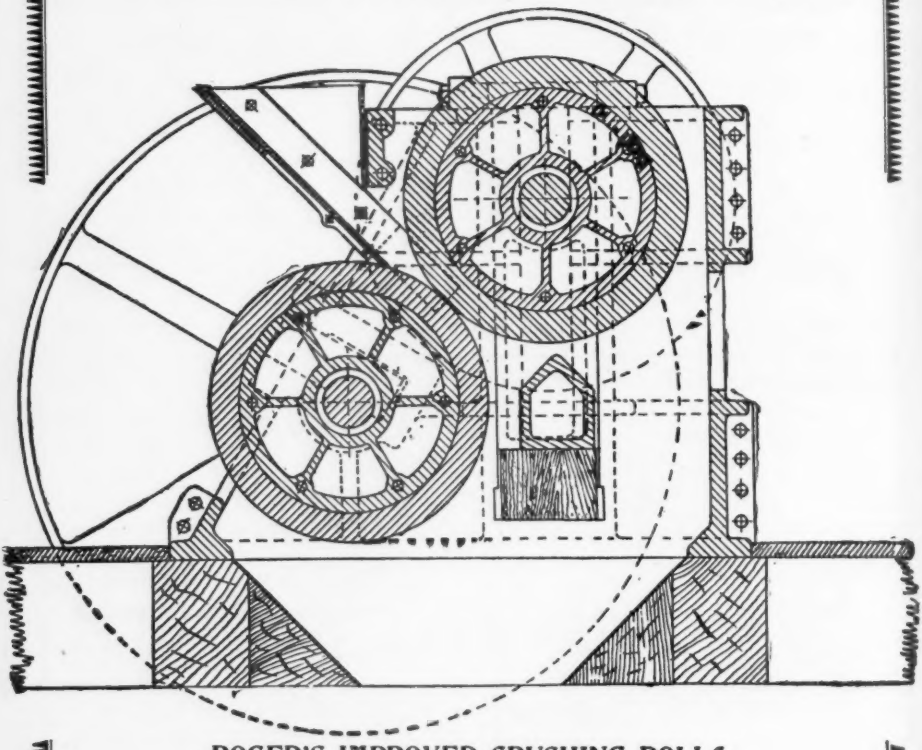

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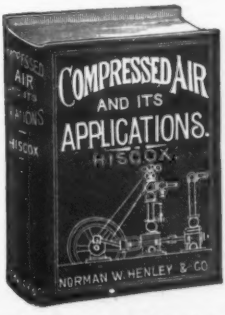

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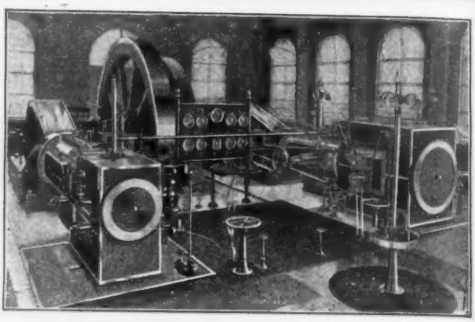

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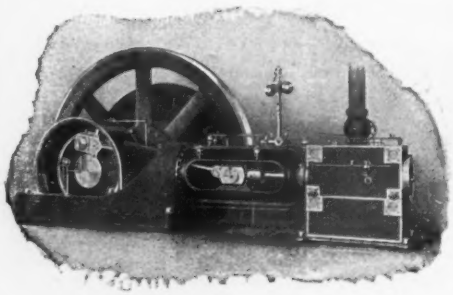

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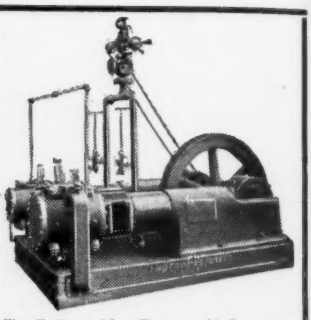

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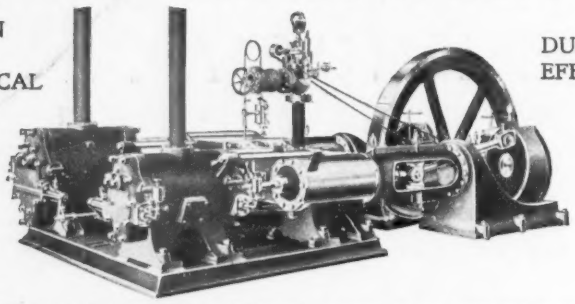

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